North Carolina
Department of Conservation and Development
Wade H. Phillips, *Director*

ECONOMIC PAPER NUMBER 62

THE MINING INDUSTRY

IN

NORTH CAROLINA DURING 1926

BY

HERMAN J. BRYSON
State Geologist

RALEIGH
1928

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LETTER OF TRANSMITTAL

RALEIGH, N. C., February 1, 1928.

To his Excellency, HON. A. W. MCLEAN,
Governor of North Carolina.

SIR:—I have the honor to submit herewith, as Economic Paper No. 62, a review of the Mining Industry in North Carolina for the year 1926. In this report are taken up the statistics of production of the various minerals that were mined in the State during 1926; it also gives descriptions of new plants and the occurrence of the minerals on which reports have been prepared during the year. The year 1926 has been the most important one in the history of the industry in the State.

Very respectfully,
WADE H. PHILLIPS,
Director.

FOREWORD

The present report, entitled the "Mining Industry in North Carolina During 1926," attempts to outline briefly the status of the mining industry in this State during 1926. The statistics published have been collected by the Division of Mineral Resources of the Department of Conservation and Development with the cooperation of the United States Geological Survey and the United States Bureau of the Census and in some cases the general status of each industry has been verified by a personal investigation.

There have been included short reports on the mineral deposits which have been investigated during the past year. Also extracts from reports which are out of print referring to important mineral deposits have been included.

HERMAN J. BRYSON,
State Geologist.

MINING INDUSTRY IN NORTH CAROLINA DURING 1926

BY HERMAN J. BRYSON

INTRODUCTION

The mining and quarrying industries in North Carolina are at the present time in a more prosperous and substantial condition than ever in the history of the State. This condition has been brought about by better transportation facilities; by more efficient management of companies operating mines and quarries; by more efficient and modern mining equipment; and by the greater demand and better prices for the products. Especially is this true of the non-metallics, as brick and tile clays, and building stone.

The total value of the production of mineral resources during the year 1926 was greater than in any year in the history of the State. The production of each mineral shows a substantial increase except gold and iron. The greatest gain has been in the materials used for building purposes. With the price of lumber advancing, many residences are being constructed of brick and stone. In every way a building constructed of these materials is more economical in the end because the future upkeep is so much less. The fire insurance rate is less; the life of the building is much longer; the annual repair bill, as repainting, etc., is a great deal less, all of which add to the popularity of brick and stone buildings.

For the past few years little mining has been done for gold and silver except in the year 1925 when $18,615 worth of gold was produced, most of which came from the Rich Cog Mine in Montgomery County. However, during the past year, there has been a sort of revival in this industry. Considerable prospecting has been done in several counties of the State. New companies have been organized to carry on the prospecting in a systematic way and the results in several instances have been gratifying.

The heavy clay products, as brick, tile, pottery, wall coping, sewer pipe, etc., continue to lead in total production with a value of $4,235,653 while the stone, granite, trap, limestone and marble,

come a close second with a total value of $4,140,828. The increased production has not been due so much to the construction of new plants as to the increase in size and capacity of older plants.

The increase in value per ton of kaolin during the year 1925 caused a great increase in tonnage as well as total value of production during 1926. The prices, however, declined somewhat during the latter part of 1926 but the total tonnage was 2070 tons greater than in 1925. The revised figures of the total mineral production for 1926 show a value of $11,274,224, the highest on record in the State. This is an increase of $574,802 over the previous year. The minerals and ores that have been mined in North Carolina during 1926 are given below in the order in which they are discussed in the following pages: Gold and Silver, Copper, Iron, Manganese, Tin, Abrasive Materials (Corundum, Garnet, Millstone, Spinel), Asbestos, Clay and Clay Products, Coal, Cyanite, Feldspar, Kaolin, Mica, Quartz, Sand and Gravel, Stone, Talc, Pyrophyllite and Soapstone.

GOLD AND SILVER

There are over 400 localities in North Carolina where gold and silver have been mined in the past but only a few of these places were prospected during the year 1926. At the close of 1925, the Rich Cog Mine in Montgomery County closed down and no production was shown for 1926. The operating cost of this mine was a great deal more than the value of the gold produced and as a result the mine closed, the shaft flooded and it is doubtful whether or not it will be operated again.

During the latter part of 1926, a great many of the old properties were being prospected again, as well as a few new localities. A great deal of prospecting is being done in the vicinity of the old Portis and Arrington mines in Warren, Franklin and Nash Counties. The results have been very good and it has been reported that a few thousand dollars worth of gold was recovered from the ore, all of which was shipped out of the State.

In these counties the formations are principally gneisses and mica schists containing a great amount of ferruginous minerals which on weathering give a deep red color to the soil. The bed rock is from 15 to 25 feet beneath the surface and over the old workings gullies are found which are several feet deep.

The surface of the ground is covered with fragments of quartz ranging in size from very fine sand and gravel to good size boulders weighing close to an hundred pounds. The quartz is the granular or sugary quartz which breaks rather easily. These fragments are usually coated with or streaked with the oxide of iron giving them a decidedly red color. Many of the lumps as large as a man's fist contain large pieces of gold, some of which contained 40 to 45 pennyweights of the metal.

In the bottom of all the valleys, gravel beds from 3 to 7 feet thick are found. In prospecting in these gravels, gold has been found in almost every case, the average assay showing a value of $18.00 per ton. The whole area is a dredging or a hydraulicking proposition as no original veins were found. The stiff red clay, the scarcity of water and the abundant forest growth would offer great difficulties if these types of mining were undertaken.

Another very good prospect is located in Randolph County 10 miles southeast of Asheboro known as the Porter Property. This property lies near the center of the Huronian Slate belt which extends clear across the State in a northeast-southwest direction and varies in width from 20 to 50 miles. The angle of dip varies from 60 to 80 degrees toward the east.

The slate in this particular area varies from a siliceous to a pyrophyllitic material and is weathered to a depth of from 40 to 50 feet. At places, however, it is more or less felspathic which on decomposing forms a sort of kaolin clay and when wet is very plastic. The surface of the ground is covered with quartz fragments that are the result of the weathering of the numerous quartz veins which cut the older rocks. These veins, varying in width from very thin to 15 inches, are the origin of the gold. Fine gold is found in between the laminations of the slate, but this is especially true where the iron oxides are deposited in the honey combed structure of the rocks.

The samples assayed were collected by Mr. Cameron under the direction of the State Geologist and assayed by E. Ely, Dover Laboratories, Dover, New Jersey. The average for all assays is $216.04 per ton. The area covered by the samples is about 300 feet long, 100 feet wide and if worked to a depth of 50 feet would

have about 140,000 tons of material. The property is one of the most promising examined in the State.

Two companies and three individuals report that they are prospecting for gold and, if properties are found favorable, will open mines. The new companies organized are the Rowan Gold Mining Company, Salisbury, and the Uwharrie Minerals Company, Winston-Salem. The individuals are L. A. Smith, Denton; Mrs. W. B. Puett, Gastonia; and Mr. B. C. Sturgis, Wood.

Many of the old placer deposits in McDowell, Burke, Iredell, Randolph, Nash and Franklin Counties are being prospected to some extent at the present time. With the invention of new gold mining machinery, it is possible that some of these properties will be worked in the future.

There are no silver mines being worked as such in this State. The silver produced comes as a by-product from some of the gold mines and the copper mine in Swain County.

GOLD AND SILVER PRODUCTION IN NORTH CAROLINA FROM 1922 TO 1926

Year	Gold	Silver	Total
1922	$ 1,939.	$ 9.	$ 1,948.
1923	1,102.	64.	1,166.
1924	4,540.	21.	4,561.
1925	18,540.	75.	18,615.
1926	1,631.	13.	1,644.

COPPER

Due to the great interest in copper mining and prospecting in this State in the past few years, a short description of the geology of the Hazel Creek and Eagle Creek areas taken from the report of F. B. Laney is given below.

COPPER DEPOSITS OF SWAIN COUNTY

Rocks of the area.—The rocks of this region may be described under four divisions: Slate, conglomerate, graywacke, and igneous rock, probably a diorite, although possibly a gabbro.

The slate is probably the oldest of all the rocks of the region. It is a very dense black slate and usually contains varying amounts of iron sulphide, probably pyrite, although it is possible that some of this mineral may carry copper.

This slate is met with for the most part in the vicinity of Briar Knob, and extends from about $\frac{1}{4}$ mile east of Briar Knob along the top of the Smoky Mountains to a short distance east of Thunder Head; thence in an irregular line to Meadow Gap; thence irregularly northeastward to the point of beginning. In many places along the streams in this area the slate is stained with iron oxide, sometimes resembling gossan, and a few of the springs in the area show decided evidence of decomposing sulphides, the rocks through which they issue being stained with iron oxide and the waters having a decided "sulphur" taste.

From the examinations thus far made of the sulphide ore in the slates, it seems that it is only iron sulphide, and if this be true, it will probably not be worth while to spend any time in prospecting the slate area, since it is present only in small quantities and as such is worthless.

Another noticeable feature of this slate is the presence of numerous quartz veins, usually small, although rarely quite large. These veins usually follow in trend the schistosity of the slate, though often they follow one or more of the numerous sets of joints in the rock. In width they vary from less than one inch to perhaps 6 feet. The large veins, however, are very few in number. Only two or three were noticed, and these were on the top of the Smoky Mountains immediately above "Fire Scald," at the head of Bone Valley Creek. One would expect to find sulphide ores associated with these quartz veins and in a few instances this is true, but a careful examination of the larger veins failed to disclose any sulphides. The sulphide ores found associated with the quartz veins were usually with the smaller veins and were apparently only sulphide of iron.

In most localities in the western part of North Carolina, these quartz veins usually carry a very small amount of gold—only a few cents per ton—and some gold-bearing specimens are reported to have been picked up in this region. However, as careful a search as could be made in the field failed to show anything of this kind. Still it is possible that an assay of some of this quartz would show traces of gold, but probably only mere traces, since the conditions are apparently not favorable for a deposit of this metal.

Immediately overlying the slates and exposed as a rule only

on the higher ridges and "tops" are the conglomerates. These conglomerates are almost invariably fine-grained and apparently pass into the ordinary graywacke—a shaling micaseous sandstone.

The pebbles of these conglomerates consist for the most part of small subangular to well-rounded pieces of clear quartz, which in many instances has a delicate blue tinge of greatly decomposed feldspar, and of larger fragments of granite which have not been disintegrated. This rock is usually quite massive, but in many instances is more or less "platy" or schistose. It contains few or no traces of the valuable ores and is considered a barren formation.

Overlying the conglomerates and apparently in many instances grading imperceptibly into them, come the rocks designated as graywackes, which are the underlying rocks of the greater portion of the territory surveyed—about nine-tenths of it.

This graywacke is by no means uniform in character; and on the one hand passes gradually into a conglomerate, which cannot be distinguished from the first mentioned conglomerate, and on the other, into a dense, fine-grained, more or less impure sandstone, and often into a typical dark-colored shale or slate. Thus, a section made across the edges of this graywacke formation should show possibly a bed of medium to fine-grained conglomerate which would grade into a bed of sandstone similar to that just mentioned, this in turn passing sometimes abruptly and sometimes by gradual gradation into a stratum of more or less impure slate or its altered equivalent, schist. If this section be continued to any distance the condition just mentioned, with the possible omission of the conglomerate belt, will be found to repeat itself, thus giving a series of soft, slaty or schist-like strata interbedded with denser, heavier, more massive beds of typical graywacke.

These graywacke beds are also intersected by numerous quartz veins in the same manner as were the slates, the veins, however, being more numerous and having a wider distribution than in the slates.

The beds or strata all have a general northeasterly trend or strike roughly parallel with the general trend of the great moun-

tain ranges, the direction of the trend varying from N. 20° E. to N. 80° E., averaging perhaps N. 45° or 50° E. They also dip toward the southeast at angles varying from 20° to 80°, averaging about 60°.

These beds all show the effects of the intense mountain-building forces—dynamic metamorphism—which they have undergone in that they are now broken, folded and faulted, and in many places rendered highly schistose. The beds which have suffered most from this dynamic activity are, of course, the weaker strata of slaty material which lie between the heavier beds of massive sandstone or conglomerate. These are often found to be mashed and folded, knotted and contorted in a most complex manner, while the beds immediately above and below them are often only slightly affected, and thus form "walls" between which the slaty or schist-like beds lie.*

These beds of slate, having been mashed and broken to a greater extent than the other beds, have furnished easy channels for the circulation of underground waters, and hence always show more of the sulphides and other metallic minerals, also of quartz veins, than the other strata. Thus it is when other conditions have been favorable for its deposition that we find the deposits of the copper ores—copper-bearing iron sulphides—in these beds of "slate".

The igenous rock referred to in the beginning of this report is probably a diorite or a gabbro-like diorite—at least a dark-colored basic rock of this type—in the form of a dike varying in width from 25 feet to probably 125 feet. This rock was traced by a series of irregular and disconnected outcrops and boulders and by a peculiar soil which results from its decomposition, from Flint Gap, near Ekowah Branch, northeastward to a point on Proctor's Creek, about ½ mile above its junction with Hazel Creek. It is also known to extend northeast to the Matt Crisp diggings, near Siler's Bald, where it is found outcropping in the cliff immediately above the little cabin at which the prospectors stopped while working at these diggings, and while it was not found west of Flint Gap, sufficient evidence was found to warrant one in asserting that it does extend southwest from this point for a number of miles. Thus it extends not as a contin-

*The prospectors and people of the region speak of these beds of schist or slate as "slate" and of the heavier and denser beds "walling" them as "granite".

uous and unbroken line, but as a series of disconnected outcrops with numerous intermissions from a point on Eagle Creek, northwest of the mouth of Ekowah Branch, to a point on the Smoky Mountains near Siler's Bald—a distance of 15 to 20 miles.

The general trend or strike of this dike is approximately N. 50° E., but since it follows the strike of the country rock, which shows more or less variation from the average direction of trend, it also varies somewhat in the direction of its strike. There are also one and probably two abrupt breaks in it, probably caused by faulting. The most prominent of these occurs near the mouth of Mill Branch. Beginning at a point about one thousand feet southwest of Deep Gap, in the Forester Ridge, the dike may be traced without interruption to a point about ¼ mile north of the mouth of Mill Branch, at which place it ends abruptly. If, from the termination of the dike, one goes directly south about ¼ mile, it is again met with and may then be followed northwestward along its usual trend for a distance of nearly ¾ mile. This break in the dike is due either to close folding or to a displacement resulting from faulting. Indications in the immediate vicinity seem to point to the latter as the cause. The other probable fault is somewhere between the Everett Mine and Sugar Fork Gap, but could not be definitely located.

This dike rock is regarded as the most important geological feature of the district, for throughout its course the rock in near proximity to it always presents more or less indications of mineralization, containing sulphides, the product resulting from their decomposition and quartz veins; and it is along the trend of this dike that all the known authenticated deposits of copper ores occur, these ores apparently lying a short distance, from 50 to 300 feet, southeast of the dike. Thus it would seem that the dike bears some important relation to the deposition of the copper ores.

Whether this igneous rock has been the source of the copper ores which have penetrated the "slates" along its trend, or whether the fractures in the rocks along which it was intruded have been the channels through which mineralizing solutions have come up from lower depth, there is not sufficient evidence to state. However, the data collected so far seem to indicate that the igneous rock has been the source of the copper ores,

since in one locality, where the dike is crossed by Mill Branch, it contains numerous particles of a mineral which is apparently chalcopyrite, which is the copper ore at the Everett Mine, and which has also been found in other places along the trend of the dike. Many specimens of this rock were carefully collected, especially at the above-mentioned point, and careful chemical and microscopic examinations were made of these.

The ores of the area.—The ores of this area are for the most part only the commoner ores of copper and iron, although there are found a few other ores usually associated with those of copper. The following is as complete a list of the ores of the area surveyed and their places of occurrence as it is possible to make:

Native or metallic copper.—This mineral is found in small quantity at the Everett Mine. It is a secondary mineral and has resulted from the alterations of the sulphide ores.

Chalcopyrite (*copper-iron sulphide*).—This is the principal and most important copper ore of the district and is probably the ore from which all the other copper-bearing ores and minerals of the district have resulted. It occurs at the Everett and Westfeldt Mines, at the diggings in the vicinity of Siler's Meadows, on Dillie Welch's farm near Soapstone Gap, at Mill Branch where it crosses the diorite (?) dike, at the Phil Myers diggings on Ekowah Branch, and at the Cook prospect on Eagle Creek, and also possibly at the old Calhoun diggings on Briar Knob. It is reported to occur at a number of other points along the trend of the dike, but these are the only places where it was found during this survey.

Tenorite, "black copper" (*a black oxide of copper*).—This mineral, which is one of the richest of copper ores, occurs in small quantity at the Everett Mine. It is a secondary mineral which has resulted from the alteration of the sulphides of copper and is usually met with in the mines at or near the level of ground water.

Malachite (*a green carbonate of copper*).—It occurs in small quantity in the oxidized portions of the ore body in the Everett Mine.

Azurite (*a blue carbonate of copper*).—This ore occurs in the Everett Mine in the same position as does the malachite, but is

less frequently met with. These two carbonates are both secondary minerals resulting from the alteration of the sulphides. They occur in such small quantities in this region that, as ores, they are of no value. However, the green and blue stains due to their presence in or on the rocks are valuable guides in prospecting.

As to the manner of occurrence of these ores of copper, it is believed that the copper deposits do not represent fissure veins, but that they represent a replacement of the "slates" by the original sulphide ores. This has taken place along fractures, joint planes of schistosity or other structural fractures of the rocks which would have been favorable for the circulation of the mineralizing solutions.

In regard to the percentage of copper in the "copper veins" of this area, the work done thus far does not give satisfactory data for a very definite statement. However, it is probable that it will be low, somewhere between 3 per cent and 6 per cent. (Reports, some of them not reliable, from the Everett Mine, show that, while some of the ore is very rich, the average will not run much over 3½ or 4 per cent of copper, with small though varying amounts of gold and silver).

Iron does not occur in workable deposits in the area covered by this report.

Pyrite (*sulphide of iron*).—This occurs widely disseminated in small quantities in all the rocks of the area—especially in the Briar Knob slates. It is of no value in the quantity in which it apparently occurs.

Limonite (*a hydrated oxide of iron*).—This is the iron ore which accompanies the sulphides. It results from their oxidation and is the iron ore of the gossan of the upper portion of the "copper lead."

Galena (*sulphide of lead*) occurs in small quantities in association with the copper ores at the Everett and Westfeldt Mines and in the prospects near Siler's Bald. It occurs in such small quantity that as an ore it is worthless.

Sphalerite, "black jack" or zinc blende (sulphide of zinc). This mineral also occurs in small quantities associated with the

copper ores at the localities mentioned above. The quantity is so small that it is of no value.

Gold.—This metal is reported to occur with the copper at the Everett Mine. The quantity is of course small, but it is of value when worked with the copper ores. If it is true that gold is found at this mine, it will probably be met with at other places with the copper ores. It is also said to occur in some of the quartz veins—one crossing Bone Valley Creek just below Kims Hall's house, and one in an old field a few hundred yards above J. E. Coburn's house, are both said to be gold-bearing. Careful examinations of both of these in the field disclosed but little evidence in favor of the reports, but it may be that further and more detailed examination, assays, etc., would confirm the statements.

Silver.—This metal is also said to occur in small amount with the copper ores at the Everett Mine.

Rutile (an oxide of titanium).—This mineral was found in small quantity in the bed of Rutile Branch, which flows into Big Flats Branch just above Mrs. Hall's house. It is present apparently in small quantity only, and hence is probably of no value.

Production

The production of copper in 1926 was chiefly from Swain County and amounted to 1,468,796 pounds. Along with the copper, there was produced small amounts of gold and silver.

There was no production of copper during 1924 and 1925 but in 1923 the total production was 61,983 pounds. This production was from Cabarrus and Swain Counties.

None of the copper ore is smelted in North Carolina as all of the ore is shipped to Isabella, Tennessee, for reduction. It is reported that about 150 tons of ore is being shipped daily to that place and averages about 7% copper. At this rate, the production for 1927 should be close to 5,000,000 pounds.

IRON

In 1926, there was a sharp decline in the production of iron ore in this State. Of the eight companies which have operated in North Carolina, only two of them reported a production. Two types of ore were mined, hematite and magnetite.

The chief producing mine of the State is the mine at Cranberry, Avery County, owned and operated by the Cranberry Furnace Company of Johnson City, Tennessee. "The ore deposit upon which operations are conducted consist of a great number of lenses of magnetite, in granite. The occurrence of these lenses is such as to form an almost continuous vein-like structure with fairly well defined walls between which the ore is found in such quantity and with the component lenses generally so closely associated that the mining is essentially that of a vein with rigid walls and of rather flat dip. The country rock, of Cranberry granite, is of course grain and generally light color. The vein consists of epidote and dark green hornblende. Nearly everywhere the vein is bordered by a seam of epidote rock which swells out in places into the coarse vein material of epidote, quartz and hornblende. The vein material is a pegmatite in which the feldspar has been changed to epidote. Relative amounts of various minerals vary from place to place. The hornblende is a greenish black variety, sometimes forming large lenticular masses, even several feet long. Magnetite is always present where hornblende is abundant, and may occur in streaks or scattered through the hornblende. Often the large ore lenses are really granular mixtures of hornblende with lenses of magnetite scattered through them. In some cases magnetite in little seams or lenses is found in the midst of the epidote, but not commonly".

"The method of mining has been governed by local circumstances and advantage has been taken of the fact that the walls are so firm and rigid as to require only a minimum of timbering. The earlier operations consisted of quarrying the ore along the great outcrop by means of open benches, assisted by the steep easterly slope of the hillside. Four such benches were originally worked, about fifty feet apart vertically, the lowest being about 100 feet above the level of Cranberry Creek where the creek flows past the mine buildings. By degrees, following the quarrying operations, the ore was followed into the hillside by means of slopes and trackways along the foot wall. The ore was hauled out over these trackways in cars by means of small air-driven hoists, and dumped through chutes and transfer-bins by successive stages of traming and dumping until it reached

"The blast furnace plant of the Cranberry Furnace Company was originally built in 1892. After a rather unsuccessful career and having passed through the several ownerships, the plant was bought by a subsidiary of the Cranberry Iron and Coal Company, a corporation controlled by Pennsylvania capital, which owns the celebrated Cranberry Mine at Cranberry, North Carolina, the East Tennessee and Western North Carolina railroad that runs from that point to Johnson City, Tennessee, a distance of thirty-five miles, and the Linville River Railroad, running from Cranberry to Boone, North Carolina, a distance of thirty-two miles."

The blast furnace has a daily capacity of 300 tons production of pig iron. The present owners have put it into first class condition. At the end of 1926 the mine had been cleaned out, the waste or gangue crushed and sold as road material for paving the Appalachain Scenic Highway and the streets of Boone. The production for 1928 will probably be as large as in any year in the history of the mine.

"The Cranberry Furnace Company manufactures low phosphorous pig iron exclusively from the ore from the Cranberry Mine, with the exception of a small quantity of ore imported from Canada. This grade of pig iron is the best that is manufactured in this country and goes exclusively into the manufacture of high class steel." (Sears.)

The production of iron ore in 1926 amounted to 15,198 long tons. This production came from Avery and Cherokee Counties.

PRODUCTION OF IRON IN NORTH CAROLINA
1921-1926, INCLUSIVE

Year	Amount Long Tons	Year	Amount Long Tons
1921	383	1924	12,525
1922	19,279	1925	22,011
1923	59,648	1926	15,198

As shown by the table above the production for 1926 was 6,813 tons less than in 1925. This decrease in production was due to the closing of the plant for a great part of the year to the production of iron ore but during most of that time the plant produced road material in the form of crushed stone and rock dust.

MANGANESE

During the year 1926, only 55 tons of manganese was mined in this State. The entire production came from Cherokee County. The ore averaged about 39% manganese. At several localities prospecting was done but no ore was shipped. With the price of manganese steadily increasing, it is probable that several of the old mines will be reopened. Low grade ores occur in several localities in the State; in Catawba, Lincoln, Cleveland and Gaston Counties of the Piedmont section and in Ashe, Haywood, Wilkes and Clay Counties of the Mountain section.

TIN

Although no production of tin ore was reported during 1926, some prospecting was carried on in the old tin belt near Kings Mountain by the Carolina Tin Company. A small concentrating plant was built to recover the tin ore from the gravels. It occurs in the form of cassiterite, the tin oxide.

A summary of the occurrence taken from Bulletin No. 19, "Tin Deposits of North Carolina" by Joseph Hyde Pratt is given below.

GEOLOGY

The section of North Carolina and South Carolina in which the tin belt occurs is close to the border of the large area of Archean gneisses which extend over a large portion of the western part of North Carolina and the northwestern portion of South Carolina. Bordering these gneisses on the east, there is a series of granites and other igneous rocks extending from Cherokee County, South Carolina, across Mecklenberg, Cabarrus, Rowan, Davidson, Guilford, Caswell and Person Counties, North Carolina, which have a general north to northeast direction. At the extreme southern portion of North Carolina, and extending into South Carolina, there is between these granites and gneisses a band of metamorphic rocks consisting of slates, schists, limestones, quartzites and conglomerates whose age is unknown. These occur quite extensively developed in Cherokee County, South Carolina, and in Gaston, Lincoln and Catawba Counties, North Carolina, and extend for a very short distance into Iredell County, North Carolina. No more of these rocks are observed in this northeast direction until they again out-

crop in the northeastern portion of Yadkin County, extending nearly across Stokes County and almost to the Virginia line. They are in every way identical with those found further south and represent the same geological formation. Penetrating up into these rocks in Gaston and Lincoln Counties, North Carolina, there is a mass of granite which is from five to ten miles wide. The schists vary considerably in character, sometimes being very siliceous and having a gneissoid structure. The general strike of these metamorphic rocks is northeast; and it is in this belt of rocks in North Carolina that the tin ore is found. The general strike of the pegmatitic dikes and veins carrying the tin is approximately the same as that of the metamorphic rocks, N. 25° E., but near the South Carolina line there is a rather sharp bend to the westward, so that from there to Gaffney, South Carolina, the direction of the tin belt is about N. 55° E., and it leaves the schists to the east and passes through the Archean gneisses. The rocks in the vicinity of Gaffney, South Carolina, are almost entirely gneisses, similar to those found in North Carolina to the west of the metamorphic rocks and which have been referred to as the Archean. There are, then, rocks of two distinct geological periods in which the tin veins have been found: (1) Those associated with the Archean gneisses, which are found in the vicinity of Gaffney, South Carolina; and (2) those associated with the schists, which are of a later period, and with which most of the North Carolina tin is found. The ore at the Jones mine, 7 miles northeast of Kings Mountain, is in greisen veins that occur in a gneissic rock, which may be portion of the Archean gneisses to the west.

As has been stated above, the main country rocks are for the most part crystalline schists and gneisses, the former being micaceous, chloritic and argillaceous, and the latter micaceous and hornblendic. The strike of the schistosity of these rocks is usually in a general northeast direction and they dip for the most part at very steep angles to the westward. The veins in the gneisses are dipping toward the east at very steep angles.

The Kings Mountain region of North Carolina is geologically situated in a band of metamorphic rocks composed of slates, schists, limestones, quartzites and conglomerates whose age up to the present time has not been definitely determined. The

width of this belt near Kings Mountain is about 10 miles and extends in a direction about N. 10° to 20° E. Just east of Lincolnton, Lincoln County, it joins another band of similar rock, the two being separated east of Kings Mountain by a mass of granite. To the west of these metamorphic rocks are the Archean gneisses, with which the tin veins of Gaffney, South Carolina, are associated. The strata of these metamorphic rocks are tilted at very high angles to nearly vertical, and in the resultant alteration and erosion to which they have been subjected, the quartzites have resisted these influences the most, so that they now form the top of the peaks and ridges such as Kings, Crowders and Anderson Mountains, which rise 500 to 1,000 feet above the average elevation. It is undoubtedly the mass of granite which is to the east that has tilted these metamorphic rocks and thrown them into their present position.

There are a number of amphibolite dikes that have been observed cutting these metamorphic rocks, but they have made very little change in the position of the schists through which they penetrated beyond a metamorphic action. These sedimentary rocks were tilted into their present position before the intrusion of these dikes, which are following partly the lamination of the schists and their general trend; but in a few instances are cutting across the schist. In two or three instances where these dikes are cutting across the schists, there are approximately parallel to them veins of tin ore. Pegmatitic dikes are also common throughout this belt of metamorphic rocks in North Carolina and in the gneisses further to the west in South Carolina. They could be followed almost continuously from three miles above Grover, North Carolina, to the Jones mine, 7 miles northeast of Kings Mountain. In one place, a short distance below Kings Mountain, North Carolina, the pegmatitic dike was all of 200 feet wide. They follow in many cases the planes of lamination of the schist which represent lines of least resistance. Where the pegmatitic dikes are cutting across the schists, they may be following old fractures that were produced at the time of the intrusion of the amphibolite dikes.

About one-half mile below Kings Mountain the pegmatitic rocks begin to outcrop very boldly and continue in this way nearly to Grover, North Carolina, a distance of seven miles. This

mass of pegmatite varies a good deal in width in this distance, from twenty-five to six hundred feet. Just in the northern edge of the town of Kings Mountain there is another strong outcrop of the pegmatite, but from this point there is but little seen of the pegmatite northeast until Ramseur's mill is reached. Here the pegmatite has a width of about 200 feet.

A cross-section of the tin belt in the vicinity of Kings Mountain would show the following sequence: hornblende-gneiss on the western boundary, followed on the east by schists which are in many places very badly decomposed; then a narrow bed of limestone which is more or less siliceous; then quartzite; another bed of limestone; quartzite; schist; to the granite on the extreme eastern portion of the belt, having a total width of about 10 miles.

The term greisen is given to a granitoid rock composed essentially of quartz and muscovite or some related mica rich in flourine, and it is associated with this type of rock that the cassiterite, when occurring as on ore of tin, is nearly always found.

The tin ore of the Carolina belt occurs in greisen veins that are for the most part in the main mass of mica schist adjoining the gneiss on the west, and which extends in almost a continuous belt from the South Carolina line to a few miles northeast of Lincolnton, North Carolina. The width of this schist formation is approximately one mile and is bordered on the east by the limestone. At the Jones mine, seven miles northeast of Kings Mountain, the rocks are gneissic in structure. In South Carolina, where the belt has made a bend toward the west, the tin ore occurs in the greisen veins that are in gneiss.

Where the tin occurs in the large pegmatitic dikes, it seems to be in greisen veins on the boundaries of these where the fumarole action would be the greatest, and probably within the larger masses of pegmatite, where greisen veins may have formed in shrinkage cracks, developed during the cooling of the magma. It has been observed, however, for the most part, in lenshaped masses of greisen, such as are commonly found in laminated metamorphic rocks, especially schists, when pegmatitic dikes are intruded into them and which are often called "augen". In these lenses in the schist that carry tin there was

usually no feldspar present, but similar lenses were observed in the schist that did contain considerable feldspar. These, however, contained little or no tin.

In the vicinity of Gaffney, South Carolina, the greisen veins carrying tin, which are in gneiss, all contained more or less feldspar which was nearly or completely altered to kaolin.

Partial analyses have been made of two varieties of the cassiterite found in and about the town of Kings Mountain, North Carolina, one a light grayish and the other a dark brown. The results of these analyses by Professor C. W. Dabney* are given in the table below:

PARTIAL ANALYSIS OF CASSITERITE

	LIGHT GRAYISH	DARK BROWN
Stanic oxide	94.70	82.99
Tungstic oxide	.92	1.14
Sulphur	Trace	0.46
Arsenic	Trace	Trace

As is seen from the above, the percentage of stannic oxide in the light grayish variety is much higher than that in the dark brown, and this is due probably to the larger per cent of iron that was in the latter sample. These percentages of stannic oxide would correspond to 74.41 per cent of metallic tin in the light gray sample and 65.21 per cent in the dark brown. A sample of the pure cassiterite from the Jones mine has been analyzed and gave 89.95 per cent of stannic oxide which corresponds to 70.70 per cent of metallic tin.

There is a noticeable difference in the occurrence of the cassiterite in the veins of the southern portion of the belt from those towards the north. At the Ross mine, near Gaffney, South Carolina, the cassiterite is associated with more or less feldspar, which has been partially kaolinized and in some cases completely altered to kaolin, with muscovite mica and but little quartz; and so at the present stage of the development work but little solid ore is obtained, the cassiterite being readily separated from the vein material or gangue minerals without the need of any crushing. As the belt is followed north, however, quartz becomes more abundant and the veins are composed principally of quartz with mica and cassiterite, thus making a firm, compact ore.

*Bull. 74, U. S. Geol. Survey, p. 35.

This latter occurrence would make a true, typical greisen. In this section of the belt it is common to find scattered over the surface boulders from a few pounds to one hundred and fifty or more pounds in weight composed of quartz mica and cassiterite. The tin, as a rule, is imbedded more in the mica than in the quartz, and the mica in the greisen veins containing tin has a pale, apple-green color, and is flouric. There is a small amount of partially altered feldspar occasionally found associated with these veins in the schist. This variation in the occurrence of the tin is due to the country rocks in which the veins occur, those to the north being for the most part in the mica and quartz schists, while those at the Ross mine are cutting a hornblende-gneiss.

ABRASIVE MATERIALS

CORUNDUM

Corundum, one of the best abrasives known, was mined at a great number of places in the State at one time or another but due to the great expense in mining and to the discovery of the process for making carborundum little mining or prospecting has been done for this mineral in the past several years. The most important localities where corundum has been found are Buck Creek and Shooting Creek in Clay County; twelve miles southeast of Franklin in Macon County; near Webster and Sapphire in Jackson County; to the southeast of Great Hogback Mountain in Trannsylvania County; and several other places of lesser importance in Buncombe, Haywood, Madison, Mitchell and Yancey Counties.

GARNET

Although the Rhodolite Company built a plant near Willets, no production was reported for 1926.

The North Carolina producers cannot compete with the companies operating in the Adirondack Mountains of New York State. The garnet found in New York is known as almandine while that of North Carolina which is mined near Willets is known as the Rhodolite. It has been reported that the type found in New York makes a better abrasive than that mined at Willets. How true this is can only be decided by the companies using them.

MILLSTONES

The millstones or buhrstones and chasers produced in 1926 were hewn from the light-colored granite in Rowan County near Faith and Salisbury. These millstones were used principally for coarser materials, as corn and oats.

The production for the past three years has been rather small and the chief producers are Fisher and Davis and J. T. Wyatt, both of Salisbury.

SPINELS

This group of minerals is mentioned here because certain ones of it may become of economic value in the near future other than chromite and magnetite. This group includes minerals which have the general chemical composition of RO. R_2O_3 and crystallize in isometric octahedrons as illustrated by the two mentioned above. RO may be MgO, FeO, MnO, or ZnO or mixture of them; R_2 O_3 may be Fe_2O_3, Al_2O_3 or Cr_2O_3. Depending on their composition the spinels have different colors, black, green, red or gray. They are extremely hard 7-8.

Many of these are found associated with the dunite and peridotite dikes which are found in abundance in Macon and Clay Counties.

Some experimenting has been carried on in recent months to determine their value as abrasives, binder in emory wheels, and as refractories. Most of the spinels occurring in this State are so impure that a process of concentration would have to be worked before they could be used commercially.

ASBESTOS

There are two minerals mined and put on the market as asbestos; one, the silicate of calcium and magnesium, the other, hydrous magnesium silicate. The former is the amphibole variety while the latter is the chrysolite variety. Both of these minerals are about equal in heat resisting, acid, and insulating properties but the chrysolite is superior in strength and elasticity.

During the past year a plant was built near Minneapolis by the National Asbestos Company for the purpose of milling the amphibole variety of asbestos. Some four miles from the plant on the Appalachian Scenic Highway where the North Toe River

has cut a deep gorge in the rocks outcrops of asbestos occur. The asbestos (anthophyllite) forms lens-shaped masses in a peridotite which is about 300 feet wide and has been traced nearly four miles. This dike cuts the pre-Cambrian gneisses and schists. Locally the fiber is called the "long" and the "short" but all of it breaks into shreds of ¼ to 1-10 inch. It is supposed that the anthophyllite has been formed by the alteration of olivene and enstatite of the igneous rocks. By hydration and oxidation both the anthophyllite and any unaltered olivene may be converted into serpentine, and the latter partly into talc. (Ries.)

The lens-shaped masses of anthophyllite in the peridotites vary from a few inches to 30 feet in thickness and can be traced many feet along the surface of the outcrop. Much prospecting has been done to determine the extent of the "veins" of asbestos. Several tunnels and pits were dug and as a result the deposit seems to be large enough to last the plant many years.

The mining so far has been chiefly by the open pit method but two small tunnels were sent into the hillside to determine the depth. The ore is hand-picked at the mine and only that which can be used is trucked over a concrete road to the plant four miles away. At the plant, which has a daily capacity of 30 tons, the rock is crushed, fiberized and screened.

The uses of asbestos are numerous but the usefulness depends mainly on the flexibility of its fibers and fibrous structure and to some extent on its low conduction of heat and electricity, and on its moderate refractoriness. The variety mined in North Carolina is used in fireproof paints, boiler coverings, for packing in fire proof safes, and for electrical insulation where heat resistance is necessary. The best grade is used also for filtering in chemical work. There are many patented mixtures of asbestos and other materials, such as Portland cement, are now used for making such products as asbestos wood, asbestos slate, asbestolith, corrugated roofing tile, roofing felt, and flooring in offices and railway pullman and chair cars. The latter uses are rather new and as a result the demand is increasing annually.

CLAY PRODUCTS

During the year 1926 there was a greater production of heavy clay products than any other year in the history of the State. For the past five year period the increase has been close to $250,000 over that of the previous year. This continued increase has been brought about by the great increase in the number of buildings and dwellings made of brick. The trade at the present time is in as good condition as at any time in the past. However, the number of plants operating has not increased, the increased demand has been met by the enlargement of the older plants.

The table below gives the total value of heavy clay products produced in this State during the past five years. It can be seen that the production has almost doubled during that period.

TOTAL VALUE OF HEAVY CLAY PRODUCTS IN NORTH CAROLINA FROM 1922 TO 1926

Year	Value
1922	$2,999,822.
1923	3,656,352.
1924	4,000,431.
1925	4,170,445.
1926	4,256,901.

COMMON BRICK

There are only a few counties in the State that do not contain clay suitable for the manufacture of common brick. The clays suitable for such brick are both the residual and sedimentary clays. Many of the counties have clays suitable for the manufacture of pressed brick, face brick or decorative brick. A great deal of attention has been paid in the past few years to details in the manufacture of common brick and as a result a better and more homogeneous brick has been put on the market. From year to year in the past five years the increase in production has just about kept pace with the extensive building program put on in the State. Practically all of the new high school buildings have been constructed with brick manufactured in the respective counties.

HIGH GRADE BRICK AND TILE

The high grade brick and tile produced are manufactured from high grade sedimentary clay or from clay shale. In 1926, eight establishments engaged in the manufacture of high grade brick and tile. The Moland-Drysdale plant at Etowah, near Hendersonville, is now manufacturing a high grade buff face brick. Mr. L. R. Whitaker, ceramic engineer for the company has been doing a great amount of experimental work with the buff burning clays located near the plant. As a result of this extensive experimenting a good quality of brick is being made. The present plant has a capacity of about 50,000 brick per day and as the market increases the management expects to enlarge the plant to take care of the demand. This plant is the first and only one of its kind in the State at the present time.

Some experimenting is being done on the white and buff burning clays and volcanic ash deposits found in Montgomery County. If the results prove satisfactory, a company will be organized to build a plant to produce a buff face brick. Many of the finer residences, churches and business buildings in the State are built of such brick which have been shipped from other states, especially Pennsylvania. At the present time, the buff face brick shipped into the State cost from $30.00 to $40.00 per thousand while such brick, if produced in this State, would reduce the cost to about $20.00 or $25.00 per thousand.

The average price of face brick produced in North Carolina in 1926 was $12.50 per thousand. This is a slight increase in price over that of the previous year.

TOTAL VALUE OF FACE BRICK AND TILE PRODUCTION IN NORTH CAROLINA IN 1926

Material	Quantity	Value
Face Brick	36,288,000	$ 549,897.
Hollow Brick	3,116,000	29,348.
Building Tile	42,078 tons	267,875.
Other Tile	38,433 tons	712,913.
Total		$1,560,033.

There are seventy-two brick plants operating in forty-one counties of the State producing in 1926, 260,884,000 common brick valued at $2,665,620. Five of the plants also produced

36,288,000 face brick valued at $549,897. Six of the plants produced hollow brick and hollow building tile with a total of 45,188 pieces valued at $297,223. One plant produced drain tile, sewer pipe, flue lining and wall coping, the total production was 37,443 tons. Henderson County leads with a total of five plants operating. Only one plant produces a buff face brick.

NUMBER OF BRICK AND TILE PRODUCED IN NORTH CAROLINA DURING 1926 BY COUNTIES

County	Common Brick	Face Brick	Tile (*Tons*)
Alamance	5,250,000	....	....
Bertie	2,000,000	....	....
Burke	800,000	....	....
Cabarrus	2,100,000	....	....
Chatham	19,178,000	....	15,019
Cleveland	400,000	....	....
Columbus	1,242,000	375,000	4,708
Craven	4,240,000	....	....
Cumberland	11,504,000	....	....
Davidson	1,850,000	....	....
Durham	2,000,000	....	....
Forsyth	3,200,000	....	....
Gaston	14,513,000	....	....
Guilford	....	....	41,049
Halifax	13,396,000	....	....
Harnett	7,100,000	....	....
Henderson	25,907,000	....	....
Iredell	14,000,000	....	....
Johnston	8,375,000	....	....
Lee	9,885,000	....	....
Lenoir	1,000,000	....	....
Montgomery	9,200,000	....	....
Nash	12,300,000	....	....
Orange	2,800,000	....	....
Pasquotank	1,900,000	....	....
Pender	600,000	....	....
Pitt	2,250,000	....	....
Randolph	3,150,000	....	....
Rowan	7,500,000	....	....
Robeson	2,500,000	....	....
Rockingham	661,000	....	....
Rutherford	4,400,000	....	....
Sampson	900,000	....	....
Stanly	3,562,000	18,296,000	....
Stokes	7,540,000	8,000,000	....
Surry	2,000,000	....	....
Union	2,792,000	9,617,000	....
Washington	1,590,000	....	....
Wayne	39,995,000	....	22,861
Wilkes	1,300,000	....	....
Total	254,880,000	36,288,000	83,637

Of the 100 counties in North Carolina, 42 reported a production of brick. The county producing the largest number of brick was Wayne whose production was 39,995,000 common brick.

Henderson was second with a production of 25,907,000. The county producing the smallest number of brick was Cleveland which reported a production of 400,000.

LIST OF BRICK AND TILE PRODUCERS IN NORTH CAROLINA IN 1926

NAME OF COMPANY OR PRODUCER	ADDRESS	PLANT LOCATION	
		TOWN	COUNTY
W. T. Jeffrys	Graham, N. C.	Graham	Alamance
Mebane Brick Yard	Mebane, N. C.	Mebane	Alamance
Trollinger & Montgomery	Mebane, N. C.	Mebane	Alamance
Aulander Brick Co	Aulander, N. C.	Aulander	Bertie
Duckworth Brick Co	Morganton, N. C.	Morganton	Burke
Peerless Brick Co	Concord, N. C.	Concord	Cabarrus
Cherokee Brick Co	Merry Oaks, N. C.	Brickhaven	Chatham
Carolina Fireproofing Co	Charlotte, N. C., Box 18	Gulf	Chatham
Carpenter & McGill	Kings Mountain, N. C.	Kings Mountain	Cleveland
Roger Moore's Sons & Co	Wilmington, N. C.	Acme	Columbus
Clarke Brick & Tile Co	New Bern, N. C.	Clarks	Craven
Red Brick Co	New Bern, N. C., Box 506	New Bern	Craven
Stevenson Brick Co	5 Craven St., New Bern	New Bern	Craven
The E. A. Poe Brick Co	Fayetteville, N. C.	Fayetteville	Cumberland
Ideal Brick Co (B. L. Langdon)	Slocomb, N. C.	Slocomb	Cumberland
L. A. Smith & Son	Denton, N. C.	Denton	Davidson
Cunningham Brick Co (Shale Brick)	Thomasville, N. C.	Thomasville	Davidson
Cheek & Belvin	Durham, N. C.	Durham	Durham
R. W. Hedgecock	Winston-Salem, N. C., R-7	Bethania	Forsyth
Hedgecock & Hine	14th St., Winston-Salem	Winston-Sa'mR7	Forsyth
R. F. Byerly	Winston-Salem, N. C.	Winston-Salem	Forsyth
J. W. Harrison	Lowell, N. C.	Lowell	Gaston
Kendrick Brick & Tile Co	Mt. Holly, N. C.	Mt. Holly	Gaston
Pomona Terra-Cotta Co	Pomona, N. C.	Pomona	Guilford
House Brick Co	Scotland Neck, N. C.	Scotland Neck	Halifax
W. E. Smith & Bros	Scotland Neck, N. C.	Scotland Neck	Halifax
Grant Brick Works	Weldon, N. C.	Weldon	Halifax
Lillington Brick Co., Inc	Box 900, Raleigh, N. C.	Lillington	Harnett
D. S. Hildebrand	Box 4, Brickton, N. C.	Brickton	Henderson
Sherrel Brick Co	Fletcher, N. C.	Fletcher	Henderson
The Moland-Drysdale Corp	Hendersonville, N. C.	Etowah	Henderson
Fletcher Brick Works	Fletcher, N. C.	Fletcher	Henderson
H. McKenzie Brick Works	Box 938, Asheville, N. C.	Fletcher	Henderson
Statesville Brick Co	Statesville, N. C.	Statesville	Iredell
Meadow Brick Co	Four Oaks, N. C.	Four Oaks	Johnston
Selma Brick Co	Raleigh, N. C.	Selma	Johnston
Sanders & Beasley	Smithfield, N. C.	Smithfield	Johnston
L. C. Isenhour	Colon, N. C.	Colon	Lee
Sanford Brick & Tile Co	Sanford, N. C.	Sanford	Lee
Moseley Brick&Shingle Co	Kinston, N. C.	Kinston	Lenoir
Mt. Gilead Brick Co., Inc	Mount Gilead, N. C.	Mt. Gilead	Montgomery
T. L. Maness	Star, N. C.	Star	Montgomery
Faison Brick Co	Rocky Mount, N. C.	Rocky Mount	Nash
Nash Brick Co	Rocky Mount, N. C.	Rocky Mount	Nash
Hillsboro Brick Co	Hillsboro, N. C.	Hillsboro	Orange
Orange Brick Co	Durham, N. C.	Durham	Orange
Elizabeth City Brick Co	Elizabeth City, N. C.	Elizabeth City	Pasquotank
W. H. Booth	Burgaw, N. C.	Burgaw	Pender
Dail Brick Works	Greenville, N. C.	Greenville	Pitt

NAME OF COMPANY OR PRODUCER	ADDRESS	PLANT LOCATION	
		TOWN	COUNTY
Elmer Rich	Ashboro, N. C.	Ashboro	Randolph
Glenola Brick Co.	High Point, N. C.	Glenola	Randolph
Piedmont Brick Co.	Liberty, N. C.	Liberty	Randolph
The Arey Br. & Lum. Co.	Box 493, Salisbury, N. C.	Salisbury	Rowan
W. C. Bracey	Rowland, N. C.	Rowland	Robeson
J. M. Hopper Construct. Co.	Leaksville, N. C.	Leaksville	Rockingham
S. W. Isenhour	Salisbury, N. C.	East Spencer	Rowan
Bostic Brick Co.	Lattimore, N. C.	Bostic	Rutherford
D. W. Dowdy	Roseboro, N. C.	Roseboro	Sampson
Yadkin Brick Yards	New London, N. C., Rt. 2	New London	Stanly
Carolina Shale Brick Co.	Box 18, Charlotte, N. C.	Norwood	Stanly
Pine Hall Brick Co.	Winston-Salem, N. C.	Pine Hall	Stokes
M. A. Walker & Co.	Winston-Salem, N. C.	Walnut Cove	Stokes
Hedgecock Brick Co.	Walnut Cove, N. C.	Walnut Cove	Stokes
R. E. Hines	Mt. Airy, N. C.	Mt. Airy	Surry
Seaboard Shale Br.&Tile Co.	Box 18, Charlotte, N. C.	Shaleton	Union
Plymouth Brick Co.	Plymouth, N. C.	Plymouth	Washington
Borden Brick & Tile Co.	Goldsboro, N. C.	Goldsboro	Wayne
		Sanford	Lee
H. Weil & Bros.	Goldsboro, N. C.	Goldsboro	Wayne
Gordon Brick Co.	North Wilkesboro, N. C.	N. Wilkesboro	Wilkes
W. S. Welbourn	Wilkesboro, N. C.	Wilkesboro	Wilkes

POTTERY

There has been a steady increase in the development of the pottery industry in North Carolina for the past few years. There is a well developed pottery industry in the State, the production in 1926 being greater than that of any previous year. The demand for hand-painted art pottery made in this State has extended far beyond its borders. Many carloads are shipped each year to the large northern cities especially New York, Philadelphia, and Washington.

There are plenty of clays in this State suitable for making high grade pottery which are the finer alumina sediments underlying the river terraces found in many of the broader valleys, the better clays being found usually near the shore line of the terraces. Such clays are found underlying the terraces along the Catawba River, north of Morganton and Mt. Holly, Burke County, and near Blackburn and Catawba, Catawba County; the South Fork of Catawba River, just north of Lincolnton, Lincoln County; the Yadkin River, near Wilkesboro, Wilkes County; Elkin, Surry County; including the old terraces of the Deep River, near Ulah and Whynot, Randolph County; in Buncombe and Henderson Counties along the French Broad River. In the eastern part of the State along the Cape Fear River, near Fayetteville, Cumberland County; the Neuse River near Goldsboro,

Wayne County; and Contentnea River, a tributary of the Neuse, in Wilson County, near Wilson, are similar deposits of clay.

Production

The value of the production of pottery in North Carolina during 1926 was $31,248. The number of pottery manufacturers were seven operating in five different counties, Buncombe leading with three producers. There was produced red earthenware, red and brown white lined cooking ware, stoneware and art pottery.

VALUE OF DIFFERENT TYPES OF POTTERY IN NORTH CAROLINA IN 1926

POTTERY	VALUE
Red Earthenware	$ 3,850.
Red and Brown White Lined Cooking Ware	700.
Stoneware	4,400.
Miscellaneous	22,298.
Total	$31,248.

LIST OF POTTERY PRODUCERS IN NORTH CAROLINA IN 1926

NAME OF COMPANY OR PRODUCER	ADDRESS	PLANT LOCATION	
		TOWN	COUNTY
Brown Bros. Pottery Co	Arden	Arden	Buncombe
Pisgah Forest Pottery	Brevard Road, Arden	Arden	Buncombe
Omar Khayyam Pottery	Candler	Candler	Buncombe
Reems Creek Pottery Co	Weaverville, N. C.	Weaverville	Buncombe
Wm. Penland Potter	Candler, N. C.	Candler	Buncombe
Hilton Pottery Co	Hickory, N. C. R-1	Hickory	Catawba
Log Cabin Pottery	Guilford College, N. C.	G'ford College	Guilford
The Jugtown Pottery	Steeds	Backwoods	Moore
North State Pottery Co	Sanford, N. C.	Sanford	Lee
Kennedy Pottery	Wilkesboro, N. C.	Wilkesboro	Wilkes

COAL

The coal fields of North Carolina are confined to the Deep River section of the Triassic Basin. The field does not seem to be capable of being developed into a very large producing property.

A great deal of work has been done in testing the coals to determine their value for by-products. Dr. Wm. Gage of Washington spent several weeks in the area running tests. He stated that he was satisfied with the results of his experiments.

The Carolina Coal Company has, during the past year, installed a larger hoisting machine in order to increase the daily capacity of the mine. The Erskine Ramsey Company has also made several improvements in order to increase the capacity of its mine. A new company, the Gulf Coal Company, has been organized and is now opening a new mine near Carbonton. The coal is an anthracite and tests are being made to compare its heating value with the Pennsylvania and Virginia coals. Just how much anthracite there is available is yet to be determined. The seam so far has been averaging about 5.5 feet in thickness. The production from these mines will probably be greater this year than that of any previous year.

COAL PRODUCTION IN NORTH CAROLINA FROM 1921 TO 1926

Year	Quantity (*Long Tons*)	Year	Quantity (*Long Tons*)
1921	23,438	1924	57,094
1922	78,570	1925	65,153
1923	36,019	1926	59,936

As shown by the table above, the production in 1926 was slightly less than that of 1925. This decrease was due principally to the time lost in cleaning out the mines and to the installation of new machinery. The companies this year have adopted the method of rock dusting instead of sprinkling in order to prevent further accidents due to explosions.

PRODUCERS OF COAL IN NORTH CAROLINA IN 1926

NAME OF COMPANY OR PRODUCER	ADDRESS	PLANT LOCATION	
		TOWN	COUNTY
Carolina Coal Co	Cumnock, N. C.	2 miles east of Cumnock	Chatham
Erskine Ramsey Coal Co	Cumnock, N. C.	Cumnock	Lee

CYANITE

Since cyanite is one of the most widely discussed minerals, especially in the refractory trade, it is fitting that something be said relative to its occurrence, distribution and possible uses.

Cyanite usually occurs in long bladed crystals or in coarsely bladed columnar masses. The color varies from white to blue, sometimes the center of the blade is blue with white margins; rarely green, gray or black. It is transparent to translucent

with a vitreous to pearly luster. The hardness varies in the different directions from 5 to 7 in the scale of hardness. The specific gravity varies from 3.56 to 3.67. The chemical composition, $Al_2\ SiO_5$, and other chemical and blowpipe properties are similar to those of andalusite and sillimanite.

The mineral cyanite is charactertistically developed in regions subjected to intense regional metamorphism. The greatest occurrence in this State is in the gneisses and mica schists of pre-Cambrian age. It is often associated with mica, garnet, staurolite, quartz and corundum. However, in certain localities, it occurs in lens-shaped masses in the form which is known locally as the "massive" variety. This massive variety is sometimes practically pure cyanite running as high as 90 or 95 per cent.

Many of the uses are questionable but there is a possible use in a great many different ceramic bodies, especially in the refractory materials. Experiments and tests have been carried on with cyanite to determine its value in the following materials: spark plugs, refractory brick, porcelain ware, both the china and electrical; sagger clays; in glass manufacture to add toughness; also it has been reported that with copper it forms an alloy which would compete with steel. It is more or less in an advanced experimental stage at the present time.

Cyanite has been found in many localities in this State, occurring in lens-shaped masses of high grade material and in schists. From a commercial standpoint, the schists offer by far the greater possibilities.

Cyanite is known to occur in large quantities in a schist in Yancey County on the north end of the Black Mountain Range. In this particular locality it makes up from 10 to 40 per cent of the rock mass. The accessory minerals are chiefly quartz, mica, and garnet with smaller amounts of tourmaline, staurolite, and corundum. The property of J. A. Pollard, Burnsville, N. C., offers great possibilities. A process of concentration has been perfected which guarantees 98% pure cyanite, the remaining 2% being quartz and white mica. It has been proven, however, that these materials are not exactly detrimental to refractory bodies since both take a comparatively high temperature and also act as a bonding material.

Other occurrences are on the property of Judge C. B. Hyatt, J. L. Hyatt and J. F. Shinn just to the south of Micaville; on the property of I. V. Moffatt on Cattail Mountain; near Black Mountain on the properties of Dr. Clifford Porter, Mr. McQueen, Mrs. W. C. Wall and J. O. Burgin. The material near Black Mountain is more the "massive" variety rather than the schist. It also occurs in Clay County on the property of N. N. Rogers; in Iredell County on property of R. L. Morrison; in Haywood County on properties of E. K. Parton and G. C. Plott; also in many sections of Cherokee, Graham, Caldwell, Jackson, Mitchell, Avery and Wilkes Counties. There is probably as much cyanite in North Carolina as in any other State in the Union.

FELDSPAR

The feldspar industry is becoming one of the most important mineral industries in the State. The industry last year ranked fourth in value of production, being surpassed only by brick and tile, granite, and sand and gravel.

In the principal feldspar belt, which extends in a northeast-southwest direction over the counties of Avery, Mitchell, and Yancey, several important developments have taken place within the past few years while others are under consideration. Probably the most important development to take place in the industry is the completion of a feldspar grinding plant by the Tennessee Mineral Products Company near Penland on the C. C. and O. Railroad. This plant is one of the largest and best equipped in America, having a capacity of 150 tons per day. It is so equipped and operated that uniformity can be assured for any of the grades of ground feldspar. This plant and the North State Feldspar Company plant at Micaville are large enough to grind a great part of the feldspar produced in the western part of this State.

However, there are other producers, as Golding Sons of Erwin, Tenn., that use considerable crude material from the North Carolina deposits. All of these companies own and operate their own mines, thereby assuring a uniformity of composition. The two chief types of feldspar used by these companies are high potash spar, or orthoclase and soda spar, or albite.

Details of operation of the new plant at Penland follow: crude materials from the mines are first hauled in cars on a narrow-

gage railroad to a loading station. Here it is reloaded on a cable car and carried to a 250 ton bin, from here the material is carried on an S-A apron feeder to a three-inch grizzly. It drops from here into a thirty-inch picking belt 138 feet long which carries it into a row of twenty 150 ton crude storage bins. From here the material is hauled by hand to two reliance crushers. Leaving the crushers, the spar is conveyed by two fourteen-foot conveyors to an elevator which carry it to the top of the plant. These discharge into a fourteen-foot conveyor which in turn transports it into the Dodge Shuttle conveyor, emptying into intermediate storage bins. From these bins a horizontal conveyor carries the material to the foot of another elevator emptying into the James Automatic Feeder.

A short conveyor carries the material to three eight by forty-eight feet Hardinge mills. After several hours grinding, elevators connecting with each mill transport the powdered material through an air separator. All the material which does not pass a certain screen test is carried back to the mills and ground again.

The finished product from mills of this type is used for purposes which demand the highest grade of materials including dental enamels, electrical porcelain, white ware, (as china, etc.,) tile, sanitary porcelain, castiron enamels, sheet-iron enamels, glass and abrasives.

Recently several large deposits have been examined which will probably be developed in the near future. The property of J. A. Pollard, Yancey County, and that of C. B. Hyatt, J. L. Hyatt and J. F. Shinn near Micaville has an abundance of good feldspar suitable for the ceramic trade. The property of the latter three men will probably be developed this year at a cost of $500,000.

It has been reported that within a radius of six miles from Spruce Pine several million tons of feldspar are available. With such an enormous quantity of crude material available, and with the completion of a power line from Marshall to Spruce Pine there is a possibility that in the near future other grinding plants will be located in that vicinity, three of which are under consideration at the present time.

Production

In 1926, sixty-one companies and individuals reported a production of feldspar. Mitchell County leads with thirty-one and Yancey second with twenty-one. The total production for the year was 91,433 long tons valued at $602,020 or 44% of that produced in the United States. At the close of 1926, two grinding plants were operating in the State.

There is given in the table below the production of feldspar in North Carolina from 1921 to 1926.

PRODUCTION OF FELDSPAR IN NORTH CAROLINA 1922 TO 1926, INCLUSIVE

Year	Amount in Tons	Value	Average Price Per Ton
1922	56,043	$333,745	$5.06
1923	57,622	350,636	6.26
1924	97,075	640,403	6.60
1925	76,806	496,563	6.47
1926	91,433	602,020	6.59

As shown by the table above the average price per ton in 1926 was the second highest on record. The increase in price is due to the fact that more feldspar was ground in this State than heretofore.

PRODUCTION OF FELDSPAR IN NORTH CAROLINA IN 1926 BY COUNTIES

County	Amount in Long Tons	Value
Avery	1,539	$ 8,344
Mitchell	60,328	486,866
Yancey	25,506	92,099
Undistributed	4,060	14,711
Total	91,433	$602,020

PRODUCERS OF FELDSPAR IN NORTH CAROLINA IN 1926

NAME OF COMPANY OR PRODUCER	ADDRESS	PLANT LOCATION	
		TOWN	COUNTY
C. W. Burleson Co.	Plumtree	Plumtree	Avery
Vance & Barrett	Plumtree	Plumtree	Avery
Eureka Mining Co.	Plumtree	Plumtree	Avery
A. I. Miller	Senia	Senia	Avery
Dave E. Pitman	Plumtree	Plumtree	Avery
D. A. Brewer	Newland	Newland	Avery
T. B. Vance	Plumtree	Plumtree	Avery
Tar Heel Mica Co.	Plumtree	Plumtree	Avery
D. T. Vance			
Clyde Pitman	Cranberry	Bellevlue	Avery
L. B. Barrett	Plumtree	Plumtree	Avery
Big Cove Mines	Canton	Canton	Haywood
Otto Frick			
R. U. Garrett Mica Co.	Sylva	Sylva	Jackson
Thomas & Willis	Boonford	Boonford	Mitchell
Fortner & Murdock	Boonford	Boonford	Mitchell
W. A. Howell	Toe Cane	Toe Cane	Mitchell
G. W. Greene	Toe Cane	Toe Cane	Mitchell
Penland Feldspar & Kaolin Company	Penland	Penland	Mitchell
J. A. & L. A. Conley	Penland	Penland	Mitchell
R. L. Burkhead	Lexington	Spruce Pine	Mitchell
W. D. Wilson & Co.	Ledger	Ledger	Mitchell
Dr. C. E. Smeth, Prop.			
Renfro & Fox	Green Mountain	Green Mountain	Mitchell
Tom Laws	Green Mountain	Green Mountain	Mitchell
R. C. Dayton	Green Mountain	Green Mountain	Mitchell
M. D. Bailey	Toledo	Green Mountain	Mitchell
H. M. Bailey	Green Mountain	Green Mountain	Mitchell
Oscar Murdock	Boonford	Boonford	Mitchell
Geo. C. Howell	Boonford	Boonford	Mitchell
J. H. Willis	Boonford	Boonford	Mitchell
T. C. Robinson	Boonford	Boonford	Mitchell
F. C. Jarrett	Boonford	Boonford	Mitchell
Dock Henline	Spruce Pine	Beaver Creek	Mitchell
Thos. L. McNeal	Bandana	Bandana	Mitchell
Carolina Mineral Company	Penland	Spruce Pine	Mitchell
Paul Willis, Sec.			
J. E. Burleson Mica Co.	Spruce Pine	Spruce Pine	Mitchell
James A. Mayberry	Spruce Pine	Spruce Pine	Mitchell
Erwin Feldspar Co., Inc.	Trenton, N. J.	English Knob	Mitchell
Controlled by Golding Sons			
Clinchfield Products Corp.	Trenton, N. J.	Hawkins Mine	Mitchell
Controlled by Golding Sons			
Golding Sons	Trenton, N. J.	Spruce Pine	Mitchell
North State Feldspar Corp.	Trenton, N. J.	Micaville	Mitchell
Controlled by Golding Sons			
Penland F'spar&Kaolin Co.	Penland	Penland	Mitchell
Isaac H. Bailey, Pres.			
The Whitehall Co.	17 Battery Pl., N. Y. City	Penland	Mitchell
J. C. Pitman	Penland	Penland	Mitchell
M. G. Ashely	Thermal City	Thermal City	Rutherford
H. C. Smith	Burnsville	Burnsville	Yancey
G. D. Harris	Windom	Windom	Yancey
W. B. Robinson	Micaville	Micaville	Yancey
R. R. Hise	Micaville	Micaville	Yancey

NAME OF COMPANY OR PRODUCER	ADDRESS	PLANT LOCATION	
		TOWN	COUNTY
L. W. Presnell	Kona	Kona	Yancey
C. H. Warrick	Green Mountain	Green Mountain	Yancey
J. T. Fox	Day Book	Day Book	Yancey
Lewis Robinson	Burnsville	Burnsville	Yancey
H. F. Harris	Burnsville	Burnsville	Yancey
Bedford & Watson	Burnsville	Burnsville	Yancey
Talmage Woody	Kona	Kona	Yancey
D. N. Woody	Kona	Kona	Yancey
L. W. Willis	Windom	Windom	Yancey
T. L. Edge	Micaville	Micaville	Yancey
Carolina Min. Prod. Corp. Paul Willis, Sec.	Greenville, S. C.	Micaville	Yancey
Pollard Clay Co. J. A. Pollard	Memphis, Tenn. 626 Memphis Cotton Exch.	Burnsville	Yancey
J. R. Garland	Kona	Lunday	Yancey
Dr. J. E. Ewing & Buchanan	Boonford	Kona	Yancey

FELDSPAR GRINDING PLANTS IN NORTH CAROLINA IN 1926

NAME OF COMPANY OR PRODUCER	ADDRESS	PLANT LOCATION	
		TOWN	COUNTY
North State Feldspar Co. Controlled by Golding Sons	Trenton, N. J.	Micaville	Yancey
Tennessee Min. Prod. Co.	Beverly Farms, Mass. Knight Building	Penland	Mitchell

KAOLIN

The production of kaolin clay in North Carolina in 1926 was obtained from Haywood, Macon, Mitchell, and Yancey Counties. Mitchell County continues to be the most important clay producing county of the State.

Some important developments took place during the last year. The Harris Clay Company at Spruce Pine rebuilt the old plant there and a greater production is predicted for this year. The overburden was removed from the clay deposit, the mine cleaned out and new equipment supplied. The clay deposit near Penland owned by the same company has been stripped of the overburden over a large area and the production from it will be greatly increased.

The Pollard Clay Company, near Burnsville, has just recently installed a steam drying system in its plant. Since the installation several hundred tons of high grade clay have been shipped. At the present time a force of fifteen men is employed

in the mine and at the plant. The daily production is close to fifty tons but can be increased as the market demands. The deposit of clay owned by this company is one of the best found in this State. There is a greater percentage of clay recovered than from any other deposit which is being mined at the present time.

A very promising deposit of clay owned by J. W. Ferguson, of Waynesville, located in Macon County near Franklin just off the Dillsboro-Franklin road, was examined during the past year. Considerable drilling and tunnelling has been done revealing a deposit of several thousand tons of crude clay. The per cent of recoverable clay is very large. It is possible that this deposit will be developed in the near future.

The production of kaolin clay in 1926 amounted to 20,719 tons valued at $331,487 or an increase of 2,079 tons in quantity and $11,888 in value. The price decreased from $16.60 to $16.00 or 60 cents per ton. The kaolin was used principally in the manufacture of pottery, enamel and paper trades.

PRODUCTION OF CLAY (KAOLIN) IN NORTH CAROLINA IN 1926 BY COUNTIES

County	Tons	Value
Haywood	139	$ 2,502.
Macon	1,220	17,650.
Mitchell	12,661	204,551.
Yancey	6,699	106,784.
Total	20,719	$331,487

PRODUCTION OF CLAY (KAOLIN) IN NORTH CAROLINA FROM 1922 TO 1926

Year	Amount (*Tons*)	Value	Average Price Per Ton
1922	14,656	$214,692	$14.65
1923	23,793	369,518	15.55
1924	16,966	277,526	16.34
1925	18,649	319,599	16.60
1926	20,719	331,487	16.00

The above table shows a decrease in value per ton but a substantial increase in tonnage and value of total production.

During 1926, five producers reported a production of kaolin clay, Mitchell County leading with a total of three producers.

PRODUCERS OF KAOLIN IN NORTH CAROLINA IN 1926

NAME OF COMPANY OR PRODUCER	ADDRESS	PLANT LOCATION	
		TOWN	COUNTY
Harris Clay Company	Dillsboro, N. C.	Lundy	Haywood
General Mica & Clay Co.	Franklin, N. C.	Franklin	Macon
Harris Clay Company	Dillsboro	Spruce Pine	Mitchell
Harris Clay Company	Dillsboro	Penland	Mitchell
Penland Feldspar&Kaolin Co.	Penland	Penland	Mitchell
Norman G. Smith	Spruce Pine	Spruce Pine	Mitchell
Pollard Clay Co.	Burnsville	Burnsville	Yancey

The Harris Clay Company has long been one of the leading kaolin producers. During the past year this company reported a production from three different mines, two of which were located in Mitchell County and one in Haywood.

MICA

North Carolina continues to be one of the leading mica producing states. In 1926, the production came from Avery, Catawba, Macon, Mitchell and Yancey Counties.

Much of the mica produced in this State comes from small mines which are worked intermittently by farmers at times when crops do not require attention. Since the feldspar and kaolin mining has become an important industry, most of the mica produced comes as a by-product from these mines. However, a few mines are operated for mica alone and yield some fine sheet mica.

The price of mica is rather low due to the fact that it comes as a by-product. Several large companies operate grinding mills for the scrap and a few operate plants for preparing sheet mica for the market. Grinding plants are located at Spruce Pine, Penland, Plumtree and Rutherfordton while plants for cutting mica are located at Hazelwood, Asheville, Spruce Pine and Plumtree.

PRODUCTION OF MICA IN NORTH CAROLINA FROM 1922 TO 1926, INCLUSIVE

Year	Sheet Value	Scrap Value	Total
1922	$119,767	$65,923	$185,690
1923	188,317	65,794	254,081
1924	108,656	59,620	168,276
1925	88,624	91,574	180,529
1926	150,362	54,048	204,410

The production as shown by the table above is the largest since 1923. The value of sheet mica almost doubled that of 1925. The prices at the end of 1926 were much better than at the beginning of the year and the production for 1927 will probably be greater than that of 1926.

PRODUCTION OF MICA IN NORTH CAROLINA IN 1926 BY COUNTIES

County	Sheet Pounds	Value	Scrap (*Tons*)	Value	Total Values
Avery	10,269	$ 1,600	404	$7,191	$ 8,791
Catawba	8,365	2,164	....	....	2,164
Macon	11,828	1,177	126	2,120	3,297
Mitchell	129,449	29,504	781	13,737	43,241
Yancey	136,703	33,293	244	4,596	37,889
Undistributed	403,699	82,624	1,325	26,404	109,028
Total	700,313	$150,362	2,880	$54,048	$204,410

PRODUCERS OF MICA IN NORTH CAROLINA IN 1926

NAME OF COMPANY OR PRODUCER	ADDRESS	PLANT LOCATION	
		TOWN	COUNTY
L. B. Barrett	Plumtree	Plumtree	Avery
David T. Vance	Plumtree	Plumtree	Avery
James A. Mayberry	Spruce Pine	Hughes	Avery
Tar Heel Mica Co D. T. Vance	Plumtree	Plumtree	Avery
Vance & Barrett	Plumtree	Plumtree	Avery
P. F. Grindstaff	Linville Falls Ashford	Ashford	Avery
Edward Hughes	Frank	Frank	Avery
J. M. Jones	Hughes	Hughes	Avery
Carpenter, Daniels & Co	Hughes	Hughes	Avery
McKinney Bros	Spruce Pine	Hughes	Avery
Patton & Murphy	Celo	Celo	Avery
J. H. Poteat	Spruce Pine	Toe River Spruce Pine Hump Back Mtn	Avery Mitchell
A. S. Taylor	Plumtree	Plumtree	Avery
W. W. Wiseman	Ingalls	Newland	Avery
J. Peter Benfield	Plumtree	Plumtree	Avery
D. Buchanan	Spear	Newland	Avery
H. R. Buchanan	Spear	Plumtree	Avery
C. E. & Odes Elmore	Casar	Casar	Cleveland
Orlando Elam	Shelby	Shelby	Cleveland
Haywood Lumber & Min. Co. Thos. Crary	Naycock, N. Y.	Waynesville	Haywood
Burleson & Welsh	Hazelwood	Waynesville	Haywood
E. H. Patrick & Co	Plumtree	Cashiers	Jackson
R. U. Garrett Mica Co	Sylva	Sylva	Jackson
General Mica & Clay Co D. D. Rice	Franklin	Franklin	Macon
Rickman, Wright, Reuse & Sisk	Franklin	Franklin	Macon
Iotla Mica & Clay Co Gen. Mica&Clay Co., lessee	Franklin	Franklin	Macon
A. J. Evans	Cullasaja	Franklin	Macon
Fuller Mica Co W. F. Deneen, Sec.-Treas.	Newdale	Newdale	Macon
L. A. Gettys	Shelby	Franklin	Macon
Thos. Greene	Shelby, Rt. 5	Franklin	Macon
A. W. Reid	Franklin	Franklin	Macon
C. C. West	Franklin	Franklin	Macon
J. L. Barnard	Franklin	Franklin	Macon
M. D. Billings	Franklin	Franklin	Macon
Tennessee Min. Prod. Co	Beverly Farms, Mass	Penland	Mitchell
Penland Feldspar&Kaolin Co Isaac H. Bailey, Pres.	Knight Building Penland	Penland	Mitchell
J. C. Pittman & Co	Spruce Pine	Spruce Pine	Mitchell
Spruce Pine Mica Co H. M. Urban, Gen. Mgr.	Spruce Pine	Spruce Pine	Mitchell
Nassau Producing Co L. S. Murrill	Spruce Pine	Spruce Pine	Mitchell
Flat Rock Mica Co	Penland	Penland	Mitchell
Golding Sons	Trenton, N. J.	Spruce Pine	Mitchell
Erwin Feldspar Co	Trenton, N. J.	Spruce Pine	Mitchell
W. F. Deenen Controlled by Golding Sons	Erwin, Tenn		

NAME OF COMPANY OR PRODUCER	ADDRESS	PLANT LOCATION	
		TOWN	COUNTY
Dent & Harris	Spruce Pine	Spruce Pine	Mitchell
English Mica Co	Spruce Pine	Spruce Pine	Mitchell
Roofing Mica Co	Spruce Pine	Spruce Pine	Mitchell
B. C. Burgess	Spruce Pine	Spruce Pine	Mitchell
J. E. Burleson Mica Co	Spruce Pine	Spruce Pine	Mitchell
Henry Poteat	Spruce Pine	Spruce Pine	Mitchell
J. W. Gemmill	Rock Rapids, Iowa	Spruce Pine	Mitchell
W. E. Greene	Spruce Pine	Spruce Pine	Mitchell
Southern Ore Corp	Boonford	Boonford	Mitchell
J. A. Bartlet	Spruce Pine	Spruce Pine	Mitchell
R. L. Burkhead	Lexington, Box 407	Boonford	Mitchell
John Davie	Penland	Penland	Mitchell
Dent & Sipple	Spruce Pine	Spruce Pine	Mitchell
J. S. Hall	Celo	Newdale	Yancey
Auther Patton	Celo	Newdale	Yancey
J. L. Patton	Celo	Celo	Yancey
Jack Renfro	Green Mountain	Celo	Yancey
Remer Todd	Spartanburg, S. C.	Celo	Yancey
E. M. Westall	Celo	Celo	Yancey
S. W. Blalock	Celo	Celo	Yancey
J. C. Burgin Mica Co	Celo	Newdale	Yancey

QUARTZ

The production of quartz in 1926 was somewhat less than that of the previous year. Since this State is so far from the pottery producing centers, only the ground quartz can be shipped for this purpose. Some crude material was shipped to Tennessee for fluxing in the copper smelters.

PRODUCTION OF QUARTZ IN NORTH CAROLINA IN 1926

MATERIAL	QUANTITY (*Tons*)	VALUE	AVERAGE VALUE PER TON
Crude	1,787	$ 8,473.	$ 4.73
Crushed	80	440.	5.50
Ground	267	8,544.	32.00
Total	2,134	$17,457.	$14.41

PRODUCERS OF QUARTZ IN NORTH CAROLINA IN 1926

NAME OF COMPANY OR PRODUCER	ADDRESS	PLANT LOCATION	
		TOWN	COUNTY
A. W. Ellis	Blue Ridge, Ga	Regal	Cherokee
Oliver Quartz Co	Charlotte	Mt. Holly	Gaston
Penland Feldspar&Kaolin Co	Penland	Penland	Mitchell
J. C. Pitman	Penland	Penland	Mitchell
Whitehall Co	New York City	Penland	Mitchell

SAND AND GRAVEL

The production of sand and gravel continues to rank third in value of minerals produced in the State. The production in 1926 showed a great increase over that of the previous year.

Probably the most important development in the sand and gravel industry is that of the Southern Sand & Gravel Company, Inc., Sanford, N. C. The property owned by this company comprises of a tract of land approximately 400 acres of gravel land together with 200 acres of land through which Fish Creek, the source of water supply, runs. This creek is a tributary of the Cape Fear River and the plant is approximately two miles from the river. The 400-acre tract was thoroughly prospected and from the estimate contains 15 million tons of marketable sand and gravel. The formation is red clay gravel and in some parts a white sand gravel is found.

The method of handling the material is as follows: It is mined by digging with two one and one-quarter yard steam shovels, conveyed to the plant in Weston dump cars on a narrow gage railroad, dumped into a hopper and from there conveyed by a 24-inch belt into the scrubber and after being washed is rejected from the scrubber into a battery of steel perforated conical screens ranging from 2½ inch perforations to ¼ inch perforation, sizing the material into four bins for gravel and one for sand. The material after washing meets all the requirements of State and Federal Highway specifications.

The cubical capacity of the plant is 5,800 tons and has a shipping capacity of 1,500 tons per 10-hour day.

The plant is located on the Atlantic and Western railroad about five miles from Lillington, in Harnett County. From the main line of the above mentioned railroad the company built its own siding, one and a quarter miles long. Just below the plant the track installed allows twelve loaded cars to be stored.

The radius of the market of this plant is about 125 miles taking in Durham, Raleigh, Greensboro, High Point and Wilmington. The company ships over the Seaboard, Norfolk and Southern, Atlantic and Yadkin and Atlantic Coast Line.

PRODUCTION OF SAND AND GRAVEL IN NORTH CAROLINA FROM 1922 TO 1926, INCLUSIVE

Year	Quantity (*Short Tons*)	Value
1922	764,940	$ 634,434.
1923	2,052,917	1,437,539.
1924	1,112,650	889,050.
1925	1,108,035	886,351.
1926	1,434,839	968,021.

PRODUCTION OF SAND AND GRAVEL IN NORTH CAROLINA IN 1926 BY COUNTIES

County	Tons	Value
Anson	454,666	$302,414.
Buncombe	176,000	204,000.
Carteret	3,760	1,316.
Forsyth	60,000	21,000.
Harnett	226,025	178,265.
Henderson	691	491.
Iredell	10,500	6,300.
Mecklenburg	100,000	40,000.
Montgomery	18,400	3,680.
Moore	260,500	128,864.
Northampton	79,093	59,863.
Rutherford	25,200	18,103.
Sampson	8,004	1,725.
Scotland	12,000	2,000.
Total	1,434,839	$968,021.

PRODUCERS OF SAND AND GRAVEL IN NORTH CAROLINA IN 1926

NAME OF COMPANY OR PRODUCER	ADDRESS	PLANT LOCATION	
		TOWN	COUNTY
W. R. Bonsal Co.	Hamlet	Lilesville	Anson
Hedrick & Wade	Lilesville	Lilesville	Anson
Buquo Sand & Stone Co.	Asheville	Asheville	Buncombe
Marshall Sand Co.	Black Mountain	Black Mountain	Buncombe
Grove Stone & Sand Co.	Asheville	Swannanoa	Buncombe
Frank W. Elliott	Catawba	Catawba	Catawba
Shell Rock Lime Co.	New Bern, N. C.	New Bern	Craven
	27 S. Front St.		
Atlantic Coast Line	Wilmington	Garysburg	Cumberland
Orinoca Supply Co.	Winston-Salem	Winston-Salem	Forsyth
Powell Paving Co.	Winston-Salem	Winston-Salem	Forsyth
J. L. Beal	Gastonia	Gastonia	Gaston
Standard Sand & Grav. Co.	Lillington	Lillington	Harnett
L. C. Nix	Zirconia	Zirconia	Henderson
N. C. Amiesite & Stone Co.	Hendersonville	Balfour	Henderson
Home Ice & Oil Co.	Hendersonville	Balfour	Henderson
R. C. Belk Sand Co.	Mt. Holly	Mt. Holly	Mecklenburg
Pat Harmon	Candor	Candor	Montgomery
Paul C. Harmon, Mgr.			
Norfolk & South. Ry. Co.	Norfolk, Va.	Rubyatt	Montgomery
		Raleigh	Wake
		Sims	Wilson
S. W. Wilson & Sons	West End	West End	Moore
Aberdeen Sand Co., Inc.	Aberdeen	Aberdeen	Moore
Lawrence Stone & Gravel Co.	Raleigh	Garysburg	Northampton
Smith&Price Sand&Grav. Co.	Elizabethtown, Tenn.	Logan	Rutherford
W. A. Smith, Operator			
Jobe Bros.	Coeburn, Va.	Logan	Rutherford
Second Broad River Sand Co.	Johnson City, Tenn.	Forest City	Rutherford
J. T. Rich	Garland	Garland	Sampson
Gale Sand Co.	Gibson	Green Pond	Scotland
Southern Sand&Gravel Co.	Sanford	Little River	Harnett

STONE

The stone industry has long been one of the leading industries of the State and the production has increased almost constantly from year to year since the industry began to be thoroughly advertised and the various stones became known. It is also one of the oldest industries known in the State.

Under the head of "Stone" is included all granite, no matter for what purpose used; sandstone; marble and other forms of limestone for agricultural purposes, this including also the marls of the Coastal Plain. In recent years stone has come to be used very largely in the making of concrete and a large proportion of the stone from some of the quarries is used entirely for this purpose. In the table below there is given the value of the production of the various stones produced in North Carolina from the year 1922 to 1926, inclusive.

PRODUCTION OF BUILDING STONE IN NORTH CAROLINA FROM 1922 TO 1926, INCLUSIVE

Year	Granite	Marble, Limestone and Marl	Total
1922	*$2,325,940.	$288,341.	$2,614,281.
1923	* 3,641,778.	349,313.	3,990,091.
1924	* 3,001,615.	336,590.	3,338,205.
1925	* 2,865,040.	825,486.	3,690,506.
1926	* 3,847,062.	338,811.	4,285,873.

GRANITE

Granite is the most important building stone produced in this State for several years. Surry and Rowan Counties are the chief producing centers of the State. The "Salisbury" and the "Mt. Airy" granites are known all over the United States. These granites are as good as any produced.

Several big contracts have been received in the past year by the North Carolina companies, one of the largest being that received by the North Carolina Granite Corp., of Mt. Airy, to supply "Mt. Airy" granite for the Arlington Memorial Bridge at Washington.

Production

During 1926 there were 41 operators who quarried in 14 counties of the State. The value of the 1926 production was $3,802,017 or an increase of $936,977 over that of 1925. This production includes granite, rhyolite, trap and other stone used in concrete.

USES OF GRANITE PRODUCED IN NORTH CAROLINA IN 1926

Uses	Tons	Cubic Feet	Value
Building Stone	23,420	284,920	$ 354,220
Monumental Stone	5,180	62,770	237,018
Paving Blocks	38,370	....	258,134
Curbing and Flagging	909,500	555,490	594,525
Crushed Stone for Railroad ballast, &c.	110,250	....	141,103
Concrete	1,405,990	....	2,066,182
Other Purposes	3,390	....	150,834
Total	2,496,100	903,180	$3,802,017

*Includes granite, and allied stone.

MARBLE AND OTHER FORMS OF LIMESTONE

MARBLE

During the past year the Regal Blue Marble Company at Regal closed its plant. Since the plant was closed the quarry has been flooded and it is probable that it will not open again. Plans were on foot for some time to sell out to the Art Mosaic Tile Company but the plans did not materialize, at least nothing has been done up to the present time.

A new company, however, has bought property near the station of Marble, below Andrews, and expects to open a quarry to the production of marble for building stone, road material and other purposes. It is reported also that a small furnace will be constructed to make experiments in extracting the metal magnesium from the high grade dolomitic marble. If the tests prove that it can be done economically a plant will be constructed for this purpose in the near future.

Work has already been started on the plant which is to manufacture the marble for monumental purposes. The property has been thoroughly core drilled and considerable work done in moving the light overburden. The results of the core drilling revealed an unlimited supply of both the "Regal Blue" and "Confederate Gray" as well as smaller amounts of the white which can possibly be used for statuary.

It has been believed for many years that too much "jointing" occurred in the marble for it to be used in the building industry but this has been disproven by extensive core drilling. Blocks have been quarried which reach a maximum 4x13 feet without a flaw.

The new Cherokee County courthouse at Murphy was built of the "Regal Blue". The building is one of the most beautiful county buildings in the State. The company had a great deal of trouble in cutting the stone for this building because the saws were not set to cut accurately. A great deal of recutting had to be done and as a result much money was lost in this extra work. About 35,000 cubic feet of cut stone was used.

Due to the recent developments in that particular section a promising future is predicted for the marble industry in this State.

Since only one company produced marble in 1926, the figures cannot be revealed.

LIMESTONE AND OTHER MATERIALS

The production of limestone in 1926 showed a great increase over that of the previous year and it is predicted that the production for 1927 will be much greater due to the developments near Hot Springs, in Madison County, and near Fletcher, in Henderson County.

During the last year, investigations were made of the marls and shell rock of the Trent and Castle Hayne formations in the counties of Jones, Craven and Onslow to determine their value for Portland cement.

REPORT ON MARLS ALONG TRENT RIVER

Location.—The particular deposits examined lie principally on the east and south side of Trent River, however some material was found on the opposite side of the same river. The property is known as the Dan Whitford property and covers about 2,400 acres of land. Just south of the property the Trent River makes a quick turn from an almost eastward direction to a northwestward direction. It flows in this direction for a short distance and makes another turn to the northeast. At a short distance below this turn, Island Creek joins the Trent. Between the first sharp turn and Island Creek is the property of Dan Whitford. Across the river or on the west bank is the Scott property of 150 acres where the old marl pits are located.

Materials.—The marl deposits on the Dan Whitford property outcrop along the Trent River for a distance of nearly two miles and are seen exposed back from the river for at least one-half mile. This whole area is underlain with marl to a depth of several feet. The cliffs along the river are from 15 to 30 feet high and are composed of solid masses of marl and shell rock. The overburden on this entire tract of land is at no place over 4 or 5 feet thick and in most cases is only a few inches, probably 6 or 8. This is shown by the fact that farmers cannot plow the land to any depth due to the very thin layer of soil overlying the marl. Over several acres the land has been abandoned to agricultural purposes due to the too thin layer of soil. This occurs even as far back from the river as a half mile. In some places the "peaks" of marl are exposed to the surface. No drill holes were sunk to test whether or not the marl was con-

tinuous from the river back to the most distant outcrop. It is only reasonable to believe that the whole area is underlain with marl.

Across the Trent river from the Dan Whitford property is the Scott tract that contains about 150 acres. Along the river the marl outcrops as a sort of cliff the entire length of the property. Back from the river at a considerable distance, about 200 yards, a pit has been opened showing the marl just beneath the surface. The overburden on this property is thicker than on the property of Dan Whitford, averaging about 5 or 6 feet. Of the 150 acres at least 100 is underlain with available material. The thickness of the marl of this place is about 20 feet. Since no holes were drilled to test the thickness it is only an estimate as shown by the river cliff.

To the north of the Scott property is the Simmons property, on which the old marl plant is located. There are several acres underlain with a high grade marl and shellrock with a thickness of probably 15 or 20 feet. This is shown in the old marl pit from which the marl was taken for many years to be used as a fertilizer.

The total area underlain by available high calcium marl and shellrock is about 2 miles long and about one mile wide. These figures are estimates rather than actual measurements. There is enough material to last for many years within easy reach of a plant. This area is by no means all of the land in that section that is underlain with a high grade marl and shellrock. On this basis with an average recovery several million tons of marl and limestone are available, at least enough to supply the demand of a large plant for 50 years or more.

One hundred samples were taken from the Dan Whitford property and were analyzed by Dr. Randolph of State College. The average analyses as given by Dr. Randolph are given below:

	MARL	SHELLROCK	COMPOSITE
SiO_2	3.86	8.96	6.94
Fe_2O_3	0.58	0.58	0.58
Al_2O_3	1.00	1.06	1.56
$CaCO_3$	91.96	87.46	89.07
$MgCO_3$	2.20	2.18	1.10

These analyses show that the materials of the Trent River section are as suitable for Portland cement as any other raw

materials used for that purpose at the present time. In fact they run less in iron and magnesium carbonate and higher in calcium carbonate than any other raw materials used elsewhere.

The analyses of the limestone below the marl shows even a better analyses than the marl. These analyses are given below as determined by Dr. Randolph:

	LIMESTONE (Near River)	LIMESTONE (One Mile Back)
$Si\ O_2$	3.65	1.48
Fe_2O_3	0.65	0.40
Al_2O_3	0.30	1.13
$CaCO_3$	95.18	94.52
$MgCO_3$	0.64	0.37
$MgCO_3$	0.64	0.37

This material runs extra high in Calcium Carbonate and very low in iron. It would make a white cement.

CLAY DEPOSITS

A good grade of clay is found on the Dan Whitford property overlying the Trent formation of marl and limestone. This clay extends over an area of more than 100 acres and is from 10 to 15 feet thick. It occurs about one mile back from the river and is entirely a steam shovel proposition as there is scarcely any overburden at all. It could be easily trammed or trucked to the Trent River and from there sent by barge to the plant.

Below are the analyses submitted by Dr. Randolph at State College.

	SECONDARY O'ERBURD. ORIG.	26.1% REM.	ON PROPERTY No. 1	No. 2	NEW BERN
$Si\ O_2$ (comb)	33.24	53.02	63.91	49.50	51.76
$Si\ O_2$ (free)	32.00	----	----	11.30	5.00
Fe_2O_3	2.53	3.42	3.81	4.56	6.42
Al_2O_3	17.08	23.08	16.19	19.28	18.45
$CoCO_3$	11.22	15.16	13.91	12.91	15.06
Loss	2.33	3.16	----	----	3.26

These clays are rather high in silica but by a simple washing process the free silica could be easily removed. After removing the silica they compare with any of those being used elsewhere in Portland Cement.

Some trouble might be encountered in removing the overburden from the marl. The marl is generally "pitted" or "peaked" with the depression filled with sand or clay. Since this runs

more or less uniform it could possibly be taken care of in the mix.

As a whole I am well satisfied with the results of the investigation from a geologic standpoint, especially in regard to the amount and accessibility of materials. I have also compared the analyses as given by Dr. Randolph with the analyses of raw materials used at other places in Portland cements. Generally speaking they show a better grade of material than that found elsewhere. There is no doubt that a high grade cement can be made from the raw materials found so abundantly along the Trent River.

Since the above report was made several other good deposits have been located along Trent River southwest of New Bern. Among the most important are the Simmons tract of several hundred acres and the Foscue property of about 150 acres. Also good clays have been found within a few miles of the plant site.

As a result of the investigations, examinations and analyses, a $3,000,000 Portland Cement Plant is under construction by the Carolina Cement Company of New Bern. The president of the company is Mr. J. A. Acker of Port Huron, Michigan, and the Secretary-Treasurer is Mr. R. C. Clark, of Kansas. The officers state that the initial capacity will be 1,500,000 barrels annually. The capacity will be increased to meet the market no matter what it may be. It is the most important development in the mineral industry which this State has ever secured. It is also one which has long been needed.

PRODUCTION OF MARBLE AND OTHER FORMS OF LIMESTONE, 1922 TO 1926

Year	Value
1922	$288,341
1923	349,313
1924	336,590
1925	825,486
1926	338,811

The decrease in total production is due to the closing down of the Regal Blue Marble Company of Regal. While the marble production decreased, the limestone production greatly increased.

PRODUCERS OF MARBLE AND OTHER FORMS OF LIMESTONE IN 1926

NAME OF COMPANY OR PRODUCER	ADDRESS	PLANT LOCATION	
		TOWN	COUNTY
Regal Blue Marble Co.	Murphy	Regal	Cherokee
Craven Contracting Co.	New Bern	New Bern	Craven
Shell Rock Lime Co.	New Bern	New Bern	Craven
B. & C. Lime & Stone Co.	Asheville	Fletcher	Henderson
B. C. Buquo Lime Co.	Hot Springs	Hot Springs	Madison
T. E. Love & R. E. Honeycutt	Stanfield	Stanfield	Stanly
N. C. Talc & Mining Co.	Hewitts	Hewitts	Swain

TALC, PYROPHYLLITE AND SOAPSTONE

These three minerals are usually considered under one head because they are very much alike in their physical properties and are used generally for similar purposes. The talc comes chiefly from Swain, Cherokee and Madison Counties; the pyrophyllite from Moore County; and the soapstone from Ashe County.

The talc deposits of Cherokee County, especially those along the Southern Railway between Murphy and Andrews, have been investigated recently to determine the quantity and quality of material available. All of these deposits lie within a few feet of the railroad, in most cases on the railroad right-of-way. The marble lies on the south and a quartzite on the north of the deposits. The talc is an alteration product from the mineral tremolite. In many of the deposits small crystals of undecomposed tremolite were found in the talc which cause much trouble during grinding.

The talc as a whole is a very good grade and it is probable that many of these deposits will be worked within the near future. Mr. J. M. Kilpatrick, Marble, N. C., an old talc miner, expects to develop some of the properties which lie nearest the railroad.

Some important developments have taken place in Moore County relative to the mineral pyrophyllite. The R. T. Vanderbilt Company of New York took over the plant and property of the Standard Mineral Company near Hemp. The United Talc and Crayon Company bought the property of the Talc Products Company, rebuilt the plant and produced several carloads of

ground and manufactured talc but very soon after operation began the plant burned. The company is being refinanced and expects to build another plant at the railroad near Glendon within a short while. The former owners of the Standard Mineral Company also expect to build another plant in that locality.

The Virginia-Carolina Soapstone Company, Roanoke, Virginia, has had its property investigated and is now having the most promising deposits core-drilled. If the material proves to be suitable for the trade, quarrying will be started immediately.

PRODUCTION OF TALC, PYROPHYLLITE AND SOAPSTONE IN NORTH CAROLINA FROM 1922 TO 1926, INCLUSIVE

YEAR	QUANTITY (*Short Tons*)	VALUE
1922	2,194	$29,049
1923	6,491	89,290
1924	6,093	81,253
1925	6,040	48,550
1926	10,176	97,004

As shown by the table above, the production increased 4,136 tons while the value increased $48,454. The value for 1926 more than doubled that of 1925. The average price advanced from $8.04 to $9.53 or $1.49 per ton. This increase in price stimulated interest in this field.

PRODUCERS OF TALC, PYROPHYLLITE AND SOAPSTONE IN 1926

NAME OF COMPANY OR PRODUCER	ADDRESS	PLANT LOCATION	
		TOWN	COUNTY
Georgia Talc. Co	Marshall	Marshall	Madison
Standard Mineral Co	Hemp	Hemp	Moore
United Talc & Crayon Co	Glendon	Glendon	Moore
Va. Carolina Soapstone Co	Roanoke, Va	W. Jefferson	Ashe
N. C. Talc & Mining Co	Hewitts	Hewitts	Swain

MINERAL PRODUCTION IN NORTH CAROLINA FROM 1917 TO 1926 INCLUSIVE

Year	Total Value of Mineral Production	Year	Total Value of Mineral Production
1917	$5,411,452.	1922	$ 7,483,305.
1918	5,192,147.	1923	11,050,257.
1919	6,404,679.	1924	10,163,435.
1920	8,117,916.	1925	10,699,422.
1921	5,676,301.	1926	11,274,224.

MINERAL PRODUCTION IN NORTH CAROLINA FROM 1922 TO 1926, INCLUSIVE

Mineral	1922	1923	1924	1925	1926
Barytes	$*	$ 7,076	$*	$*	$*
Brick and Tile	2,999,822	3,656,452	4,000,431	4,170,445	4,225,653
Clay (Kaolin)	214,692	369,518	277,326	319,599	331,487
Cement Products		561,673	500,000	529,818	
Coal	388,000	132,000	224,000	283,000	243,000
Copper		9,112			178,416
Feldspar	333,745	360,636	640,403	496,563	602,020
Gold	1,939	1,102	*	18,615	1,631
Granite	2,325,940	3,641,778	3,001,615	2,865,040	3,802,017
Iron	49,415	161,603	32,512	49,511	33,045
Limestone, Marble and Marl	288,341	349,313	336,590	825,486	338,811
Mica	185,790	254,081	167,276	180,198	204,410
Millstones	*	*	*	*	*
Pottery	12,488	*	*	*	31,248
Sand and Gravel	634,434	1,437,539	889,050	886,351	968,021
Silver	9	64	*	*	13
Talc, Pyrophyllite and Soapstone	23,049	89,290	81,290	48,550	97,004
Miscellaneous	25,741	19,020	12,944	26,246	217,448
Total	$7,483,405	$11,050,257	$10,163,435	$10,699,422	$11,274,224

As is seen from the above table, the total value of $11,274,224 is somewhat greater than the total value of $10,699,422 of the 1925 production, this increase amounting to $574,802. This production was obtained from 65 counties out of the 100 in the State. The production for 1926 is the highest on record, being $223,967 greater than that of 1923 which had a total production of $11,050,257. The production for 1927 will probably be much greater than that of 1926 as several new plants have been completed during that year.

*Included under miscellaneous.

VALUE OF MINERAL PRODUCTION BY COUNTIES IN NORTH CAROLINA IN 1926

Alamance	$ 46,500.00	Jones	
Alexander	106,583.00	Lee	330,443.00
Alleghany	825.00	Lenoir	10,000.00
Anson	313,072.00	Lincoln	75.00
Ashe	10,305.00	McDowell	
Avery	48,785.00	Macon	19,938.00
Beaufort		Madison	103,996.00
Bertie	20,000.00	Martin	
Bladen		Mecklenburg	185,230.00
Brunswick		Mitchell	1,038,316.00
Buncombe	358,250.00	Montgomery	97,953.00
Burke	8,000.00	Moore	213,864.00
Cabarrus	23,100.00	Nash	114,400.00
Caldwell		New Hanover	26,739.00
Camden		Northampton	59,863.00
Carteret	1,316.00	Onslow	
Caswell	127,950.00	Orange	28,150.00
Catawba	5,400.00	Pamlico	
Chatham	289,490.00	Pasquotank	19,000.00
Cherokee	84,750.00	Pender	6,000.00
Chowan		Perquimans	
Clay		Person	
Cleveland	4,800.00	Pitt	22,500.00
Columbus	50,027.00	Polk	
Craven	45,355.00	Randolph	33,000.00
Cumberland	133,065.00	Richmond	
Currituck		Robeson	22,500.00
Dare		Rockingham	153,135.00
Davidson	19,000.00	Rowan	1,067,424.00
Davie		Rutherford	103,654.00
Duplin		Sampson	10,725.00
Durham	146,000.00	Scotland	2,000.00
Edgecombe		Stanly	303,630.00
Forsyth	188,500.00	Stokes	219,600.00
Franklin		Surry	943,000.00
Gaston	158,080.00	Swain	177,451.00
Gates		Trannsylvania	
Granville		Tyrrell	
Graham		Union	179,775.00
Greene		Vance	260,000.00
Guilford	745,695.00	Wake	255,500.00
Halifax	110,631.00	Warren	
Harnett	248,640.00	Washington	18,031.00
Haywood	2,502.00	Watauga	
Henderson	643,605.00	Wayne	461,625.00
Hertford		Wilkes	23,275.00
Hoke		Wilson	300,584.00
Hyde		Yadkin	
Iredell	233,000.00	Yancey	198,961.00
Jackson			
Johnson	90,661.00	Total	$11,274,224.00

As shown from the above table, 35 counties of the 100 in North Carolina reported no production of any kind in 1926. Rowan County shows the largest production with $1,067,424, with Mitchell coming a close second with $1,038,316. The production from Rowan is chiefly granite while that of Mitchell is feldspar, mica and kaolin. The county reporting the smallest production of any of these reporting was Lincoln with a value of only $75.00.

APPENDIX

Alamance	Brick
Alexander	Granite
Alleghany	Manganese
Anson	Sand and Gravel, Quartz
Ashe	Irone Ore, Soapstone
Avery	Feldspar, Iron Ore, Mica
Beaufort	
Bertie	Brick and Tile
Bladen	Clay
Brunswick	
Buncombe	Granite, Pottery, Sand and Gravel
Burke	Brick and Tile
Cabarrus	Brick and Tile
Caldwell	Brick and Tile
Camden	
Carteret	Sand
Caswell	Granite
Catawba	Pottery, Sand and Gravel
Chatham	Brick and Tile, Coal
Cherokee	Iron Ore, Manganese, Marble
Chowan	
Clay	Clay
Cleveland	Brick and Tile, Mica
Columbus	Brick and Tile
Craven	Brick and Tile, Limestone and Marl, Sand and Gravel
Cumberland	Brick and Tile, Sand and Gravel
Currituck	
Dare	
Davidson	Brick and Tile, Granite
Davie	
Duplin	
Durham	Brick and Tile, Granite
Edgecombe	
Forsyth	Brick and Tile, Granite, Sand and Gravel
Franklin	Gold
Gaston	Brick and Tile
Gates	
Granville	
Graham	
Greene	
Guilford	Brick and Tile, Pottery
Halifax	Brick and Tile
Harnett	Brick and Tile, Sand and Gravel
Haywood	Feldspar, Mica, Kaolin
Henderson	Brick and Tile, Granite, Limestone, Sand and Gravel
Hertford	
Hoke	
Hyde	
Iredell	Brick and Tile
Jackson	Corundum, Kaolin, Feldspar, Granite, Mica
Johnson	Brick and Tile
Jones	
Lee	Brick and Tile, Coal
Lenoir	Brick and Tile, Clay
Lincoln	Clay, Tin
McDowell	
Macon	Mica, Kaolin
Madison	Limestone, Talc
Martin	
Mecklenburg	Granite, Sand and Gravel
Mitchell	Feldspar, Kaolin, Mica, Quartz

Montgomery	Brick and Tile, Pottery, Sand and Gravel
Moore	Sand and Gravel, Pyrophyllite
Nash	Brick and Tile
New Hanover	Limestone
Northampton	Sand and Gravel
Onslow	
Orange	Brick, Granite
Pamlico	
Pasquotank	Brick
Pender	Brick
Perquimans	
Person	
Pitt	Brick
Polk	
Randolph	Brick, Gold
Richmond	
Robeson	Brick
Rockingham	Brick, Granite
Rowan	Brick and Tile, Granite, Millstones
Rutherford	Brick, Sand and Gravel, Granite
Sampson	Brick, Sand and Gravel
Scotland	Sand and Gravel
Stanly	Brick and Tile
Stokes	Brick
Surry	Brick and Tile, Granite
Swain	Copper, Limestone
Transylvania	Manganese
Tyrrell	
Union	Brick and Tile
Vance	Granite
Wake	Granite
Warren	Gold
Washington	Brick and Tile
Watauga	
Wayne	Brick and Tile
Wilkes	Brick and Tile, Pottery
Wilson	Granite
Yadkin	
Yancey	Feldspar, Kaolin, Mica

LIST OF PUBLICATIONS

NATURAL RESOURCES, a bi-weekly publication, devoted to information about and discussion relating to the conservation and development of the State's natural resources and their place in the life of the people, is mailed free upon application. Its contents are available, for use in the press or otherwise, with or without credit or acknowledgment.

There have been printed and are on hand for distribution at the prices noted a number of publications—bulletins, economic papers, volumes, reports, circulars—covering a wide variety of subjects and special studies, as follows:

MINES AND MINERALS

Bulletin 2. Building and Ornamental Stones in North Carolina, by T. L. Watson and F. B. Laney in collaboration with George P. Merrill, 1906. 8°, 283 pp., 32 pl., 2 figs. *25 cents. Cloth-bound copy 50 cents.*

Bulletin 11. Corundum and the Basic Magnesian Rocks of Western North Carolina, by J. Volney Lewis, 1895. 8°, 107 pp., 6 pl. *5 cents.*

Bulletin 13. Clay Deposits and Clay Industries in North Carolina, by Heinrich Ries, 1897. 8°, 157 pp., 12 pl. *10 cents.*

Bulletin 19. The Tin Deposits of the Carolinas, by Joseph Hyde Pratt and Douglas B. Sterrett, 1905. 8°, 64 pp., 8 figs. *4 cents.*

Bulletin 21. The Gold Hill Mining District of North Carolina, by Francis Baker Laney, 1910. 8°, 137 pp., 23 pl., 5 figs. *15 cents. Cloth-bound copies 75 cents.*

Bulletin 22. A Report on the Cid Mining District, Davidson County, N. C., by J. E. Pogue, Jr., 1911. 8°, 144 pp., 22 pl., 5 figs. *15 cents. Cloth-bound copies 75 cents.*

Bulletin 25. Zicon, Monazite and Other Minerals Used in the Production of Chemical Compounds Employed in the Manufacture of Lighting Apparatus, by Joseph Hyde Pratt, Ph.D., 1916. 8°, 120 pp., 3 pl. *15 cents. Cloth-bound copies 75 cents.*

Bulletin 28. Limestones and Marls of North Carolina, by G. F. Loughlin, E. W. Berry, and J. A. Cushman. Prepared by the North Carolina Geological and Economic Survey in cooperation with the United States Geological Survey, 1921. 8°, 211 pp., 7 pl., 3 figs. *15 cents.*

Bulletin 29. The Kaolins of North Carolina, by W. S. Bayley, prepared in cooperation with the United States Geological Survey. *50 cents.*

Bulletin 31. Deposits of Brown Iron Ores (Brown Hematite) in Western North Carolina, by W. S. Bayley. *50 cents.*

Bulletin 32. Magnetic Iron Ores of Western North Carolina and Eastern Tennessee, by W. S. Bayley. *15 cents.*

Bulletin 33. The Deep River Coal Field of North Carolina, by Marius R. Campbell and Kent K. Kimball. Prepared in cooperation with United State Geological Survey. *10 cents.*

Economic Paper 15. The Mining Industry in North Carolina During 1907, by Joseph Hyde Pratt, 1908. 8°, 176 pp., 13 pl., and 4 figs. *15 cents.*

Economic Paper 23. The Mining Industry in North Carolina During 1908, '09, and '10, by Joseph Hyde Pratt and Miss H. M. Berry, 1911. 8°, 134 pp., 1 pl., 27 figs. *10 cents. Cloth-bound copies 50 cents.*

Economic Paper 34. The Mining Industry in North Carolina During

1911-1912, by Joseph Hyde Pratt, State Geologist, 1914. 8°, 63 pp., 23 pl., 12 figs. *15 cents.*

Economic Paper 49. The Mining Industry in North Carolina During 1913-1917, Inclusive, by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1919. 8°, 170 pp. *20 cents.*

Economic Paper 55. The Mineral Industry in North Carolina, 1918-1923, Inclusive, by Brent S. Drane, Director, and Jasper L. Stuckey, Geologist, 1925. 8°, 104 pp. *25 cents.*

Economic Paper 58. Oil-prospecting Well near Havelock, North Carolina, by Wendell C. Mansfield, of the United States Geological Survey, in cooperation with the North Carolina Geological and Economic Survey, 1927. *5 cents.*

Economic Paper 59. Oil-bearing Shales of Deep River Valley, by F. C. Vilbrandt, Ph. D., prepared in cooperation with the Department of Conservation and Development, 1927. *10 cents.*

Economic Paper 60. The Mineral Industry in North Carolina, 1924-1925, by Herman J. Bryson, Acting State Geologist, 1927. *15 cents.*

EXAMINATION OF MINERAL SPECIMENS

Samples of any mineral found in the State may be sent to the Department of Conservation and Development, Raleigh, N. C., for identification, and the same will be classified free of charge. It must be understood, however, that NO ASSAYS OR QUANTITATIVE DETERMINATION WILL BE MADE. Samples should be in lump form, if possible, and marked plainly on outside of package with name of sender, postoffice address, etc.; a *letter* should accompany sample and *stamp* should be enclosed for reply.

NORTH CAROLINA
DEPARTMENT OF CONSERVATION AND DEVELOPMENT
J. W. HARRELSON, *Director*

ECONOMIC PAPER NUMBER 63

THE MINING INDUSTRY
IN
NORTH CAROLINA DURING
1927 and 1928

BY
HERMAN J. BRYSON
State Geologist

RALEIGH
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STATE OF NORTH CAROLINA

BOARD OF CONSERVATION AND DEVELOPMENT

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LETTER OF TRANSMITTAL

RALEIGH, N. C., February 1, 1930.

To his Excellency, HON. O. MAX GARDNER,
Governor of North Carolina

SIR:—I have the honor to submit herewith, as Economic Paper No. 63, a review of the Mining Industry in North Carolina for the years 1927 and 1928. In this report are taken up the statistics of production of the various minerals that were mined in the State during 1927 and 1928; it also gives descriptions of new processes installed in mineral plants and the new plants built during those years. Also it outlines briefly the occurrences of the economic minerals found in North Carolina. The years 1927 and 1928 have been the most important ones in the history of the industry in the State.

Very respectfully,

J. W. HARRELSON,
Director.

FOREWORD

The present report, entitled the "Mining Industry in North Carolina During 1927 and 1928," attempts to outline briefly the status of the mining industry in this State during 1927 and 1928. The statistics published have been collected by the Division of Mineral Resources of the Department of Conservation and Development with the coöperation of the United States Geological Survey and the United States Bureau of the Census, and, in some cases, the general status of each industry has been verified by a personal investigation.

There have been included short reports on minerals by Dr. J. L. Stuckey, Professor of Geology, and Professor A. F. Greaves-Walker, Ceramic Engineer, North Carolina State College, Raleigh, N. C., as well as a report on "Fertilizer Value of Some North Carolina Shales," by Andrew Murphy and Dr. F. C. Vilbrandt of the University of North Carolina. All deposits of economic minerals which may prove of value in the future have been outlined by counties. This outline will be of special value to those interested in locating mineral deposits.

HERMAN J. BRYSON,
State Geologist.

MINING INDUSTRY IN NORTH CAROLINA DURING 1927 and 1928

By Herman J. Bryson,
State Geologist

PHYSIOGRAPHY OF NORTH CAROLINA

The State of North Carolina is situated on the Atlantic seaboard between 33° 50′ and 36° 33′ north latitude and between 75° 27′ and 84° 26′ west longitude, thus having a total width from north to south of 187.5 miles and from east to west of 503.25 miles. The eastern and western boundaries conform largely to the great natural confines of sea and mountains, the former with its curving shore line being more than 300 miles in length, while the latter trends northeast to southwest along the crest of the Appalachian Mountain system for over 200 miles. The northern and southern boundaries are mainly conventional lines, the former an almost due east and west line about 325 miles in length and the southern a broken line about 375 miles in length. The total area of the State is 52,286 square miles, of which 3,620 square miles are water.

The State, considered with reference to its surface features—its physiography, as it is ordinarily termed—may be divided into three parts: A western or mountain region; A central, submontaine or plateau region, usually designated as the "Piedmont" plateau region and an eastern plains region, usually designated as the coastal plain region. These three divisions follow the Atlantic border of the United States in three belts of varying width from New England to the Gulf.

MOUNTAIN REGION

The western or mountainous district, known throughout the eastern portion of the country from Pennsylvania to Alabama as the Appalachian Region, culminates in this State in a series of connected ranges that reach a height well above 6,000 feet, the highest peak being Mount Mitchell, 6,711 feet, the tallest mountain in Eastern North America.

This entire western section is a rugged mountainous plateau, lying between the Piedmont Plateau and the crest of the Smoky Mountains, the latter being the western boundary of the State. The length of this mountainous plateau is over 200 miles and varies in width from 15 to 50 miles. The total area is nearly 6,000 square miles. The Smoky Mountain chain has a general elevation of from 5,000 to 6,000 feet rising in many summits to 6,500 feet and above. The chain is broken down by several deep water gaps, the Hiwassee, the Tuckasege, and French Broad River gaps being the most important, to the level of 2,000 or even 1,200 feet. The Blue Ridge is a very sinuous, angular, and straggling chain with an elevation of from 3,000 to 4,000 feet, a few of its higher summits, about midway in the State, reach nearly 6,000 feet. This chain of mountains forms the eastern boundary of the mountainous plateau while its eastern slopes form the western boundary of the Piedmont region.

The Smoky Mountain chain and the Blue Ridge chain are connected by many north and south cross chains, of equal elevation or even greater height than the two main chains. On one of them, called the Black Mountains, is Mount Mitchell. The cross valleys have an elevation of from 2,000 to 3,000 feet, with smaller benches and marginal plateaus of from 3,500 to 4,000 feet. The most rugged part of the mountain district is found in the Linville Falls region, where many of the gorges or canyons reach a depth of 1,500 feet or more.

PIEDMONT REGION

The central hill country, known as the Piedmont plateau, attains a greater width in North Carolina than in the States to the north of it, and is also far more rugged. The western margin of this plateau has an altitude of 1,200 feet to 1,500 feet above sea level. At places there are precipitous spurs of the Blue Ridge Mountains projecting eastward and southeastward across the Piedmont section in irregular, straggling ranges.

The most prominent topographical features of this middle region of the State is a succession of broad-backed swells which have an eastward and southeastward trend. These constitute

the water sheds between a number of the large rivers which rise in the upper Piedmont or on the flanks of the Blue Ridge. The rivers reach the Atlantic through a system of wide valleys, 300 to 500 feet below the intervening divides. The area of this region is about 22,000 square miles; its altitude, descending gradually from 1,500 to about 300 feet, with an average close to 1,000 feet.

COASTAL PLAIN

The eastern low country, known as the Coastal Plain extends from the Atlantic Ocean on the east to the Piedmont plateau on the west. Its area is about two-fifths of that of the State, exceeding 21,000 square miles and embracing wholly or in part 42 counties. Its western boundary passes through Northampton, Warren, Halifax, Franklin, Wake, Johnston, Chatham, Lee, Moore, Montgomery, Richmond and Anson Counties. Along its western margin in this State it is often hilly, especially in the southwestern corner, where it forms the sandhill district. In this district the rivers as well as smaller streams cut through the softer Coastal Plain deposits to the harder rocks of the Piedmont plateau which underlie this entire area. The sandhills often appear as outliers of the Piedmont plateau, where they attain elevations of from 400 to 500 feet. North of the sandhill region the western border of the Coastal Plain seldom rises above 400 feet.

To the eastward the Coastal Plain area declines in altitude, passing from one broad flat or gently sloping plain or terrace to another until it reaches tide-level, where it embraces swamps, marshes, bays and sounds covering wide areas—this whole area from 50 miles inland from Hatteras being less than 20 feet above sea level. In this low area, in the northeastern corner of the State we find the great Dismal Swamp. The ocean is walled off from these low areas by a long linear chain of sand islands or dunes, ranging from 75 to 100 feet and upwards in height. This wall is cut at half a score of places by inlets which connect the sounds with the ocean. The total width of the plain is 125 miles.

Beyond the outer shore line the surface slopes gradually beneath the sea to the continental shelf, this belt of the North Carolina coast having a width of about 50 miles, thus constituting a submarine district of nearly 15,000 square miles. The boundary line between the submerged or *submarine division* and the emerged or *subaërial division,* although apparently fixed, is in reality very changeable. It has migrated back and forth across the Coastal Plain during the past geologic ages and there is reason to believe that the sea is now slowly encroaching on the land on account of the gradual subsidence of the latter.

INTRODUCTION

In the years 1927 and 1928, the mining and quarrying industries in North Carolina continued in the same prosperous and substantial condition as in the year 1926. Several new plants have been constructed and many old plants rebuilt during the past year. There has probably been as much money invested in new plants during that period as there has been in any like period in the history of the State. In many of the mineral industries new processes have been introduced which have brought about changes for the better in the finished products. As a result of these changes, a much higher grade material is being produced. Especially is this true in the kaolin clay, feldspar and mica industries.

During the past year, or at the most, eighteen months, eleven new mineral plants have been completed or are under construction. Four other large plants are at the present time under consideration. The total capital invested, when the plants are completed, will reach several million dollars. Such an investment of capital, in so short a time, shows that the mining men have faith and confidence in the mineral resources of this State.

During the past two years the gold and silver produced in the State came principally as a by-product from the copper mine in Swain County. A great deal of interest has been shown in the old gold and silver mines of the State. Several of the mines in Union, Davidson, Randolph, Nash and Franklin Counties are being investigated at present to determine the quality and quantity of ore remaining in them. If the results of the investigations are favorable it is probable that some of the mines will be re-opened in the near future.

The heavy clay products, as brick, tile, pottery, wall coping, sewer pipe, etc., continue to rank at the top in total production with a value of $3,862,186 for 1927 and $3,157,635 for 1928. Probably the most important development in this industry was the completing of a plant near Winston-Salem for the production of tile, such as sewer pipe, drain tile, etc.

The production of stone, which includes granite and allied stone, marble, limestone in its various forms, shows a total

value of $4,967,045 in 1927 or by far the greatest in the history of the State. This value shows an increase of $681,172 over that of the preceding year. In 1928 the total value of production decreased to $4,690,949.

The production of feldspar in 1927 and 1928 showed a substantial increase, but the production of kaolin clay was somewhat less than that of the year 1926. The prices per ton of the two materials were a little less than those of the previous year. The revised figures of the total mineral production for 1927 show a value of $12,576,882, the highest on record in the State. This increase is $1,302,658 over the year 1926. The total value of the mineral prdouction in 1928 dropped to $12,355,934. The minerals and ores that have been mined in North Carolina during 1927 are given below in the order in which they are discussed in the following pages: Gold and Silver, Copper, Iron, Manganese, Tin, Abrasive Materials, Asbestos, Barytes, Clay and Clay Products, Cement Products, Chromite, Coal, Kyanite, Feldspar, Kaolin, Mica, Monazite, Quartz, Sand and Gravel, Stone, Talc, Pyrophyllite, Soapstone and Zircon.

GOLD AND SILVER

At the close of 1928 the total output of gold in North Carolina was $23,663,766. Every year since 1799, the year in which a 17-pound nugget was found and which was the first authentic record of the discovery of gold in this State, gold and silver in varying amounts have been produced. However, during the past few years only a small amount has been recorded and this came principally as a by-product from the copper mines.

There are four areas in the State where gold ores have been found. These areas are known as follows: (1) The Northeast Belt; (2) The Central Belt; (3) The Central Syenitic Belt; and (4) The South Mountain Belt.

NORTHEAST BELT

The ores of the Northeast Belt occur in Warren, Franklin and Nash Counties and cover, so far as explored, an area of 100 square miles. The formations consist of gneisses and mica

schists, for the most part, and are rich in ferruginous minerals, where alteration and weathering have extended far below the surface. The gold appears originally to have been largely in narrow seams of quartz, which, in the process of weathering have been broken down. From the analogies of the occurrence of gold elsewhere in the Carolinas and Georgia, it is probable that the entire "country" mass of gneiss, etc., may also have gold sparingly distributed within it, and from which it has also been concentrated.

Considerable interest has been shown in this locality during the past year. A great deal of prospecting has been done on the Long and Whitehouse properties. The results of the prospecting so far on the Long property have been very gratifying. It is reported that one carload of ore shipped from the district yielded several thousand dollars in gold. Several carloads of ore are out ready for shipment at the present time. It is probable that something definite toward development of the properties under consideration will be done within the next few months.

CENTRAL HURONIAN BELT

The gold ores of the so-called Central Belt occur chiefly in the "Huronian" slate area in the counties of Montgomery, Randolph, Stanly and Union. The formations consist of schists, which are argillaceous with a siliceous tendency, dark colored and extremely hard. These schists or slates are penetrated by numerous seams of quartz, which generally seem to have the effect of enriching the ore body. This seems to be true because the richest portion of the ore is where the quartz is most abundant. Pyrite is found widely disseminated but is more abundant in the seams and joints of the schists. In some of the mines, as is true of the old Howie mine in Union County and the Black Ankle mine in Montgomery County, it is difficult to say where vein matter is not found as the rocks of the entire region are gold bearing as well as the so-called veins. Along the western side of the "slate" area the ores occur in a schist, but are not far removed from the syenite and granite.

In this Central Belt the chief prospecting has been done

in Union and Randolph Counties. The Jackson Gold Mining Company has been organized and has taken over the old Howie mine near Waxhaw in Union County. The surface equipment, which includes power plant, tipple, pumps, tram cars, etc., has been repaired and painted. Some work has been done but to just what extent is not known. A great deal of prospecting has been done in other localities in this belt but especially at the Black Ankle mine.

The Black Ankle mine is located in the northeastern part of Montgomery County about 15 miles north of Troy. This property is owned by Ed Hedrick, of Asheboro, and B. U. Hedrick, of Salisbury. It is reported that a New York company made some very flattering offers to the owners for the property. However, it seems to be the intention of the owners to develop the mine in a small way themselves.

The ore of the Black Ankle mine occurs in the typical schists and slates of the "Huronian Slate Belt." The gold is usually very fine, so fine that it floats on water, but at times small nuggets are found. It occurs in small quartz stringers and in the partings of the schists and slates. The country rock is weathered to a depth of 40 or 50 feet and is rather soft. The richer portions of the "zones" are more siliceous and consequently much harder than the leaner "zones." However, at times, it is hard to tell where the richest zones occur and the only way to determine the values is to crush and pan the ore. Assays made on the richer ore run rather high but the average of the richer zones is said to be close to $35.00 per ton.

The developments so far consist of about 1,000 feet of drilling over an area about 600 feet long, 150 feet wide and 20 feet deep. One shaft has been sunk to a depth of 52 feet, from the bottom of which east and west tunnels have been sent out to a distance of 75 feet. It is reported that over the entire prospected area gold has been found in varying amounts. A great deal of the overburden has been removed by wheel scrapes drawn by a caterpillar tractor. Some of the overburden, however, was run through the test mill and the results were satisfactory.

The test plant built on the property consists of a hopper, log washer or disintegrator, force pump, two classifiers, perforated plates, rifflles, tube mill, and amalgamation plates. Several tons of ore have been milled to date with an average recovery of $30.00 per ton. The test plant does not recover all of the gold by any means, as the tailings have shown varying amounts of extremely fine gold. It is said that the tailings show as high as $6.00 per ton and in one extreme case as high as $26.00 per ton. As a whole the property is quite interesting and offers possibilities for future development.

CENTRAL SYENITIC BELT

The Central Syenitic Belt has a width of 15 to 25 miles, running across the State in a northeast-southwest course and has long been known as the "Granite Belt." This belt covers parts of the counties of Mecklenburg, Cabarrus, Rowan, Davidson and Guilford.

The ores of the entire belt are very similar and probably of the same origin. The ores in all of the mines are auriferous and occasionally cupriferous. The latter is true especially of the Gold Hill district of Rowan and Cabarrus Counties. At times the ores are high in lead and zinc. The Silver Valley mine of Davidson County is a good example of this type of ore. Silver is found in almost all of the mines but none of the mines have been worked for silver alone. The ores are refractory only as the sulphides make them so.

The ore veins occur usually in the syenitic material, the fissures ranging from a few inches to 60 feet or more in width. These fissures are usually filled with slaty material, quartz and ore. The slates are usually very aluminous, at times approaching pyrophyllite, finely laminated and often very fissile; they are usually parallel to the walls of the veins.

The rocks of this belt have disintegrated to a great depth, sometimes 150 feet or more. At one mine, a mud-slide occurred at the 500-foot level. Due to the absence of ordinary glacial action and to the gently rolling topography in this region, the weathered surface is left practically in its original position. As a result of this regional disintegration the upper parts of

the veins have undergone a great deal of oxidation, the sulphides have been changed to oxides and at times the metal has also been removed. This is especially true of the copper sulphides. The brown ore, which was originally the sulphide, holds the gold, but in a great many places enriches as a result of the alterations which have taken place.

The old Silver Valley mine in the belt was optioned by Norrie and Tower of New York but the option expired without further development. The ore of this mine is chiefly the lead-zinc sulphide carrying varying amounts of silver. Another property known as the Wrenn property, located near Southmont, has been prospected to some extent but the results were not so favorable. Several different analyses have been made which show a copper content of 2.34%, varying amounts in gold and 50 to 75 cents in silver per ton. All of the samples assayed were taken from the surface or at shallow depths, none of which were over four feet deep.

SOUTH MOUNTAIN BELT

The fourth district in which gold is found is known as the South Mountain district. It covers parts of Burke, McDowell and Rutherford Counties. Just before the California gold rush as many as 3,000 hands could be seen working on one stream in that area. The gold of this area is free milling and occurs chiefly in the gravels of the stream beds and in the talus at the foot of Pilot Mountain. The gravels are usually just a few feet thick but occasionally they reach a thickness of 30 feet. The gravels are covered to some depth with a fine clay. The greatest hindrance to the commercial development of these deposits is the scarcity of water for hydraulic purposes. Some prospecting was done in this area during the past year.

The production of gold in North Carolina during 1927 and 1928 amounted to $1,015 and $2,366 respectively. This came chiefly as a by-product from the copper ore in Swain County.

GOLD AND SILVER PRODUCTION IN NORTH CAROLINA FROM 1923 TO 1927

Year	Gold	Silver	Total
1923	$ 1,102.	$ 64.	$ 1,166.
1924	4,540.	21.	4,561.
1925	18,540.	75.	18,615.
1926	1,631.	13.	1,644.
1927	1,015.	3.	1,018.
1928	2,366.	11,145.	13,515.

ACTIVE GOLD MINING COMPANIES IN NORTH CAROLINA IN 1927 AND 1928

Name	Address	Town	County
Rich Cog Mining Company	Eldorado	Eldorado	Montgomery
South Hill Gold Mines Company	Gold Hill	Gold Hill	Rowan
Jackson Mining Company	Waxhaw	Waxhaw	Union

INACTIVE GOLD MINING COMPANIES IN NORTH CAROLINA IN 1927

Name	Address	Town	County
Conrad Hill Syndicate	Lexington	Conrad Hill	Davidson
Greensboro Mining Company	Greensboro	Gardner Hill	Guilford
Overton Mining Company	Asheboro	Asheboro	Randolph
W. N. Brown	Cedar Falls	Cedar Falls	Randolph
L. A. Smith & Son	Denton	Denton	Randolph

Below is given a list by counties of the old gold mines which have been active at one time or other in the State.

GOLD MINES IN NORTH CAROLINA BY COUNTIES

Anson .... Hamilton

Alamance .... Robeson

Burke .... Mills, Hedge, White Bank, Hancock, Glen Alpin, Carolina Queen, Granville, Hunts Mountain, Vein Mountain.

Cabarrus .... Linker, Meadow Creek, New Nugget, Phoenix or Miami, Reed, Rocky River, Quaker City, Tucker, Johnson, Stinson, Maxwell, Black, Harris, Gannon, Saunders, McMakin, Pioneer Mills, Mauney, Widenhouse, Nugget, Eva Furr, Buffalo, Allen Furr, Montgomery, Barrier, Furness, Gibb, Faggart, Barnhardt.

Caldwell	Corpening, Pack's Hill, Baker, Fleming.
Catawba	Shuford, McCorkle, England, Rufty, Abernathy.
Cherokee	England, Peachtree. Shuford or Catawba.
Cleveland	Near Shelby.
Davidson	Silver Valley (Lead, Zinc, Gold), Silver Hill, Emmons, Cid, Welborn, Conrad Hill, Laffling, Loftin, Eureka, Black.
Davie	Gray, Butler, Isaak Allen, Callahan Mountain.
Franklin	Portis.
Gaston	Kings Mountain, Burrell-Wells, Crowder's Mountain, Patterson, Rhodes, McLean, Duffie, Robinson, Derr, Rhyne, Oliver, Farror, Long Creek.
Guilford	Deep River, Fentress, Oak Hill, Palachian, Pine Hill, Hudson, Hoover, Fisher Hill, Hodges, Twinn, Lindsay, Jack's Hill, Beason, Harland, Beard, Vickory, Lauder, Endy, Ball.
Henderson	Boylston Creek.
Halifax	Davis.
Lincoln	Hoke, Burton, Graham.
McDowell	Bracket, Town, Vein Mountain, Marion Bullion.
Mecklenburg	Yellow Dog, St. Catherine-Rudesil, Capps, Frederick, Grier, Johnson, Surface Hill, Hayes, McGee, Brawley, Smith and Palmer, McDonald, F. Wilson, Howell, Trotter, Carson, Taylor, Icenhour, Davidson, Blake, Point, Parks, Clark, Hipp, Campbell, Todd, Arlington, McGinn, Troutman, Prim, Abernathy, Alexander, Dunn, Sloan, McCorkle, Cathy, Ferris, Hunter, Moore, Stephen Wilson, Gibson, Neal, Frazier, Means, Bennet, Kerns, Henderson, Hunter, Tredinick, Ray, Ellington, Blair, Ferguson Hill, Shaffer, Poplin.
Montgomery	Moore, Reynolds, Carter, Sam Christian, Swift Creek, Dry Hollow, Bright, Ophir, Spanish Oak Gap, Island Creek, Deep Flat, Pear Tree Hill, Tom's Creek, Harbins Bunnell Mountain, Dutchman's Creek, Worth, Morris Mountain, Coggin, Saunders, Sted, Beaver Dam, Griffin, Nall, Russell, Sedberry, Rich Cogg, Iola, Montgomery, Martha Washington, Riggan Hill, Maratock and Black Ankle.
Moore	Elsie, Bell, Grampusville, Brown, Bat Roost, Shields, Cagle, Clegg, Burns.
Nash	Mann-Arrington, Argo, Thomas, Kearney, Taylor, Mann, Conyers.

Orange	Robertson.
Person	Durgy.
Polk	Red Springs, Weatherby, Potty Adams, Tom Arms, Splawn, Ponder, Riding, L. A. Mills, Carpenter, Hamilton, Neal, MacIntyre, Double Branch, Price.
Randolph	Uwharrie, Winningham, Slack, Davis Mountain, Sawyer, Winslow, Jones or Keystone, Lafflin or Herring, Delft, Parish, Bason, Empire, Redding, Southern Homesteake, Scarlett (copper), Asheboro, Tolbert, Hoover Hill, Wilson, Kindley, Conroy.
Rowan	Gold Hill, Yadkin, Dunn's Mountain, Reimer Bullion, New Discovery, Gold Knob, Dutch Creek, Atlas, Bame, Hartman, Negus, Harrison, Hill, Southern Belle, Goodman, Randleman, Roseman, Gold Coin, Park, Union (copper), Drexler, Steele, Butler, Rumpler, Yadkin.
Rutherford	Double Branch, Alta, Idler, Monarch, Carson, Glendale, Ellwood, Leeds.
Stanly	Parker, Whitney, Crowell, Barringer, Haithcock, Hearne, Flint Spring, Henderson, Lowder, Crawford or Ingram.
Union	Davis, Phifer, Price, Black, Brewer, Indian Trail, Union, Bonnie Doon, Howie, Wyatt, Washington, Penman, Grand Union, Lewis, Hemby, Moore Hill, Folger Hill, Harkness, Long, Fag Hill, Dulin, Crump, Smart, Stewart, Lemmonds, Wenona, Crowell, Butterfield, Fox Hill, Secrest, Bonnie Belle.
Wilkes	Mount Zion.
Yadkin	Dixon.

COPPER

The date of the discovery of copper in North Carolina is not known but it is probable that it was recognized very soon after the first gold mine was opened in 1799. Emmons states in his report of 1852 that "It has been known for a very long time, that the auriferous pyrites consist in part of the sulphuret of iron, and, in part, of the sulphuret of copper. In extracting the gold from the sulphurets, the latter has been neglected and allowed to flow away in the washings. Lately, however, attempts have been made, not only to save the copper of the auriferous pyrites, but to work the veins exclusively for copper. Stith's mine had been worked for its gold for many years. It was profitable; but its owner, Mr. Fentress, had given up

the business of working it for gold and it was lying useless to himself, when Mr. Stith proposed working the sulphuret for copper."

Evidently the Stith (Fentress) mine proved to be successful as Emmons later stated that "The mine is valuable" and that its success produced a "change in the working of the auriferous pyrites." The success of this mine caused others to be worked exclusively for copper.

The chief areas in which copper is found are similar to those where gold is found, namely: (1) The Syenitic Belt; (2) The Central Huronian Belt; (3) Granville and Person Counties; (4) The Western or Mountain Belt.

SYENITIC BELT

Most of the mines of the syenitic belt were, in the beginning worked for gold but due to the fact that copper was the predominant metal found they later became copper mines. The producing copper mines of this belt were located in Guilford, Rowan, Cabarrus and Mecklenburg Counties. Near the surface large bodies of ore were extracted but the result of the deeper workings were not so favorable. Since no records were kept of the older mines little is known of them.

The copper ores of this belt are chiefly chalcopyrite but malachite and the red oxide of copper are found. The chief gangue mineral is quartz with varying amounts of manganese, siderite, pyrite and limonite. The veins vary in width from a few inches to several feet with an average of about five feet. Emmons states that the "lode is bounded by slates or 'killas'; the syenite or granite on the foot wall is tough but on the hanging wall is soft."

CENTRAL HURONIAN BELT

The central Huronian belt is probably the widest and best known in the State. This belt lies to the east of the syenitic belt and extends from Rowan County eastward to Chatham. Most of the mines in this belt, as those of the syenitic belt, were in the beginning worked for gold but later became very important producers of copper.

The rocks of this entire area consist of highly metamorphosed, coarse and fine acid volcanic tuffs called schists and slates. There are also large masses of land waste included in these rocks which have been intermixed with the volcanics. Metamorphism has been so intense that it is hard to say where one type of rock stops and the other begins. Sometimes the rocks are cut by numerous dikes so abundant that the whole formation assumes a bedded appearance.

The veins occurring in the mines of this belt may be classed under three chief types, namely: (1) veins which are highly silicified; (2) veins which have been developed along fractures; (3) veins of the true quartz variety. The ores are chiefly auriferous pyrite and chalcopyrite. Sometimes quartz, the chief gangue mineral, includes free gold as well as chalcopyrite. Laney states that there were two periods of mineralization. The first period produced the high gold-low copper type while the second produced the high copper-low gold type.

PERSON AND GRANVILLE COUNTIES

The Person and Granville County copper district was at one time one of the most important in the State. The important mines of that area were worked to a depth of 350 to 500 feet. This area extends into Virginia and each State contains approximately one-half of the ore-bearing region. It is sometimes known by the names Virgilina and Blue Wing copper district.

The area lies on the east side of the so-called "Huronian Slate" belt which reaches clear across the State in a northeast-southwest direction.

The rocks of the area are highly metamorphosed and are chiefly composed of gneisses and schists. There are two chief types, greenstone schists and quartzoze sericitic schists or gneisses. Into these high metamorphosed rocks there have been intruded large masses of granite and less important masses of a more basic rock, probably gabbro.

The veins which carry the ore are composed chiefly of quartz with locally considerable amounts of epidote and calcite. They vary in width from a few inches to 15 or 20 feet and

are probably the true fissure veins. In length the veins range from a few hundred yards to four or even five miles. The ore is not evenly distributed in the veins but is concentrated locally into definite ore shoots.

The copper bearing minerals occurring in the veins are chiefly bornite and chalcocite with small amounts of chalcopyrite. The ores do not become richer with depth. Bornite is by far the most important of the copper bearing minerals.

MOUNTAIN BELT

The copper ores of the western part of the State occur in a great number of localities distributed over 12 different counties. By far the most important district is in Swain County on the headwaters of Eagle and Hazel Creeks. It is also the only present producing district of the State. The production of copper from this county is increasing annually.

The districts which have been prospected and from which copper has been produced in the past are outlined below:

In Gaston County, about two miles south of the old Tuckaseege Ford on the Catawba River, there is an area which shows six distinct copper veins, some of which are auriferous.

Another area in this same belt where prospecting has been done occurs about four miles northeast of the village of Iron. The vein is from 30 to 42 inches thick and at times is gold bearing.

Farther west in the mountain region there are three copper belts which offer promising possibilities. The areas are, in order of importance, (1) Swain County Belt; (2) The Ashe County Belt; and (3) The Jackson-Haywood County Belt.

SWAIN COUNTY

The Swain County Belt, which is now the most important copper producing area in the State, and the second largest in the South, being surpassed only by the Tennessee Copper Belt, begins in the northwestern corner of Graham County and extends in a northeast direction to the north-central part of Swain County. The entire length is something like 30 miles.

Several openings have been made along this belt, many of which show much promise. The principal areas are the Eagle Creek area, operated at the present time by the Fontana Copper Company, Fontana, N. C., and the Hazel Creek area known as the Adams-Westfelt property. The latter area is being prospected thoroughly by a newly organized company. The results of the investigations so far have been very favorable. Lately it is reported that this property has also been taken over by the Fontana Company.

The rocks of the Swain County copper belt are the typical slates, schists and gneisses of the Ocoee formations, which are probably of Cambrian age. The chief copper bearing mineral is chalcopyrite, with smaller amounts of malachite, bornite and native copper. The ore occurs in a schist varying from a typical slate to a talcose schist. The slate occurs on the hanging wall side while the talcose schist is on the foot wall. The vein varies from a few inches to 30 feet or more and dips at a great angle.

The principal development work carried on so far has been confined to one shaft, located on the headwaters of Eagle Creek. At the present writing the shaft had reached a depth of about 900 feet which follows the dip of the vein. Several cross cuts have been made at the different levels. It has been reported that the ore averages about 8% metallic copper, with an average daily production of about 400 tons. If this be true, the production for 1929 will be far the highest on record in the history of the State.

ASHE COUNTY

The Ashe County copper belt, as its name implies, occurs in the Gap Creek section in the southeastern part of Ashe County, about three miles west of the summit of the Blue Ridge and one and one-half miles east of New River. The chief mines were Copper Knob, Elk Knob and Ore Knob.

The rocks of this district are the prevalent and characteristic hornblende gneisses and schists. The ore in this belt is rather unique; vitreous copper ore, malachite, some chalcopyrite, chrysocolla, brown ore, with a little iron pyrite. Accord-

ing to the old records, the veins increased in width with depth. At Copper Knob varying amounts of gold were found, at times running as high as $3.75 per ton. The copper content ran as high as 11%. Little work has been done in this district in the past few years.

JACKSON-HAYWOOD

The Jackson-Haywood copper belt is so called because the most promising outcrops of this belt occur in these counties. However, the entire belt extends from near the center of Macon County north 35° east through Jackson, Haywood, Buncombe, into Madison County. At a great number of places on this belt openings have been made, many of which revealed ore of promise. The principal openings and mines are the Waryhut, near Webster; the Cullowhee mine on Cullowhee Mountain; and the Savannah mine, nine miles southwest of Webster. Other openings of lesser importance are Shell Ridge, Scott's Creek, Sugarloaf, Panther Knob and Wolf Creek.

During the past summer, Clarence S. Ross, Geologist of the U. S. Geological Survey, visited several of the copper districts of the State and had the following to say, according to a news dispatch from Washington, concerning the deposits visited:

"The Cullowhee Mine near Cullowhee, is probably larger and richer in copper than some of the older mines, but it has not been prospected far below the surface. The Ore Knob Mine, near West Jefferson, was at one time the greatest copper mine in the country and for a time utilized the original low grade ores after the enriched ores above them had been exhausted. The vein is 8 to 16 feet wide and was mined over a distance of 3,800 feet. . . . The Ore Knob Mine is the most promising unworked mine in the region. The vein is continuous for a long distance and contains large reserves of ore similar to that which made it valuable as a mine in the past. The ores are of the same type as those of Ducktown but are probably richer, and the potential copper supplies are large." This entire district offers wonderful opportunity for development, according to Mr. Ross.

The copper production in North Carolina has been increasing rapidly during the past few years. At the present rate of increase the production in 1929 should be close to 10,000,000 pounds.

Due to the increased production of copper in this belt it is probable that concentrating plants and possibly a smelter will be built in the vicinity of Bryson City or Sylva. The Asheville Citizen of Sunday, December 1, 1929, announced that a New York company would spend between $2,000,000 and $3,000,000 in the development of the copper mines, the erection of concentrating plants and a smelter. This announcement was made by P. J. Burgess, mining engineer representing the company.

Considerable activity is also shown in the Jackson County copper belt near East Laporte. During the summer of 1929 the Tennessee Copper Company leased the Cullowhee Copper Mine from the North Carolina Flux Company. At the present writing the company has four compressed air drills in operation and about 40 men employed in the mine. About six hundred tons of ore have been hauled to the railroad at East Laporte. It is reported that the ore averages close to 7% copper.

In the Betts Gap section of Jackson County near the Macon County line there are three distinct copper veins. The rocks of the area are the typical gneisses which are found so abundantly in the western part of the State. The ore is chiefly the sulphide, chalcopyrite, associated with the iron sulphides, pyrite and pyrrhotite, with quartz and epidote as the chief gangue. The ores of this county are probably replacements of limestones by the sulphides. Paralleling the veins and close by there are large dikes, probably gabbro.

The three veins of the Betts Gap area can be traced for a distance of 1,500 feet or more. One of the veins has been cut by a mica prospecting tunnel and shows a width of 18 feet. About 1,500 feet away on the same vein another tunnel has cut the vein for 14 feet but did not go through it. According to Mr. J. H. Wilson, of Sylva, the ore shows a copper content of from 3 to 5 per cent.

Near Cowarts, about one-half mile from the railroad, is the Gun Stocker vein. This vein contains the iron sulphides

with some chalcopyrite, the copper content being about 2 or 3 per cent. The vein is about six feet in width and can be traced for a distance of 1,000 feet or more. This vein has probably the same origin as the veins in the Cullowhee and Betts Gap areas.

Below are some notes given on the copper deposits of western North Carolina as taken from an old report:

"There is a favorable outcropping of copper near the head of Big Ivey Creek not far from the Madison and Buncombe County line, which presented a favorable appearance. There is another point only a few miles from Asheville, where there is an outcrop deserving of exploration for copper. The belt passes into Haywood County, at the head of North Hominy where there is an outcrop in every way flattering for the copper. The gossan is of excellent quality, the vein at the surface large, and the walling favorable for a copper mine.

"The zone passes thence down North Hominy to Hall's Mill, with several attractive outcrops between George Hall's and the mill. Eight or ten miles northwestward there are favorable outcrops again in the Massey Cove, and on Little Mountain, in the direction of Waynesville.

"After passing Waynesville the copper belt widens out, the zone we have been following, passing into Jackson County at the head of Scott's Creek.

"There are several points between this and the Waryhut Mine. Some of these localities have been tested by Messrs. Oram and Davis, who are the owners of 16,000 acres of land embracing these outcrops. I have been informed that the veins are of good size, and the ore (chalcopyrite) of excellent quality.

"The range or zone from the head of Scott's Creek passes along the range of the Double-top Mountain, showing the outcrops already alluded to.

"In 1860, the Waryhut Mine showed handsome specimens of malachite, chalcopyrite, and occasionally some native copper. Shell Ridge, Buck Knob and Hornbuckle may all be included in this belt.

"The old Savannah Mine is northwest of the Shell Ridge. Here the first discovery of copper in Jackson was made. At this mine is a vein of good yellow copper. This property is on a transverse section of rocks; the gneiss and syenite strike off to the northwest. The new Savannah Mine is about half a mile from the old Savannah Mine. At the depth of 25 or 30 feet is a mixture of gossan, black copper, yellow copper, etc. The vein is apparently 8 to 12 feet thick. The outcrop continues one-fourth mile northwest, and also southeastward. This zone passes northwestward crossing the county line in Bett's Gap, and shows copper on the corner rocks at the head of Cowee Creek in Macon County.

"The Buck Knob zone outcrops as a broad belt in Macon County, at the Corbin Knob, where some copper has recently been obtained. On Tessentee and Middle Creeks, in the southern part of Macon, there is a large outcrop of gossan. A large vein appears on Middle Creek, near Cabe's Mill, and the outcrop can be traced for one and one-half miles.

"A vein several feet thick appears in syenite rock, on the Patton property, near the Cartoogajay Creek, Macon County, 4 miles southwest of Franklin. Another copper property (the Waldrope property), occurs southwest from the above, at the base of the Nantehalee Mountain. The copper belt crosses the Nantehalee Mountain and passes into the southeast corner of Clay County. The zone shows on the west of the mountains, in Towns County, Georgia, where there are valuable copper properties. A noteworthy fact which I have learned is that the ores on this entire zone in North Carolina, are remarkably free from arsenical impurities.

"Another copper bearing zone occurs on the head waters of South Richland Creek. Some work has been done on the top of the Caney Fork Bald, a mountain dividing the waters of Pigeon and Tuckaseege Rivers, where a large quartz vein was cut, showing handsome copper ore. Along the spurs of the mountain, on the Pigeon or Richland side, I saw two fine gossan outcrops. Southwestward from this point, on the waters of Caney Fork, there are large exposures of gossan in Gunstocker Cove. The zone passes down Caney Fork, and crossing the Tuckasege River, runs into Cullowhee Mountain, in which Cullowhee Mine is situated. My recollection is that the vein is about six feet in thickness. It contains a rich yellow copper ore.

"From the Wolf Creek mine, southwest of the above, this range passes southwestward into Macon County, on the waters of Ellijay and Buck Creeks.

"There is another locality in Haywood County, in an entirely different formation. It is on Wilkins' Creek, 25 miles from Waynesville, down the Pigeon River. It is lithologically identical with Ducktown, and in the same geological horizon. A shaft was sunk, and a tunnel driven, which penetrated the vein for 12 or 15 feet, without reaching the opposite wall. The vein is almost solid arsenical pyrite, precisely such as the veins at Ducktown carry. I was assured that the outcrops of gossan extend for 4 miles northeastward and generally continued as prominent at the locality under consideration."

The total production of copper in North Carolina since 1900, the first year a record was kept, is 20,288,168 pounds, valued at $2,960,188. In the year 1927, the production was 5,443,115 pounds and in 1928 the production was 8,207,000 pounds. Since there was only one producer the Department cannot give the total value.

PRODUCTION OF COPPER IN NORTH CAROLINA
FROM 1926 TO 1928, INCLUSIVE

Year	Pounds	Value
1926	1,468,796	*
1927	5,443,115	*
1928	8,207,000	*

*One producer—value concealed.

COPPER MINES IN NORTH CAROLINA
BY COUNTIES

Alamance	Foust
Alleghany	Peach Bottom
Ashe	Elk Knob, Miller, Copper Knob, Ore Knob
Cabarrus	Ludowick, Boger, Hill, Phoenix, Pioneer Mills, Morrison, Crosby (Poplan), Rogers
Chatham	Clegg, Chick, Phillips
Davidson	Conrad Hill, Emmons, Cid
Gaston	Burrell Wells
Guilford	Hodges, Fisher Hill, Gardner, Lindsay, Jack's Hill, Twin Mine, Fentress, Gardner Hill, North State
Haywood and Jackson	Waryhut, Cullowhee, Savannah, Shell Ridge, Scotts Creek, Sugarloaf, Panther Knob, Wolf Creek, Blue Wing
Lincoln	Graham
Mecklenburg	Roy, Ferris, McGinn, Kerns, Cathey, Dunn, Leary
Person and Granville	Big America, Holloway, Mastodon, Poole, Buckeye, Gilles, Copper World, Yancey, Copper King
Randolph	Spencer, Sloan
Rowan	Gold Hill, Dutch Creek, Cline, Dan Hopkins
Swain	Fontana, Forney, Hazel Creek

IRON

Iron ore was first produced in North Carolina in 1729, when small shipments of ore were made to England. The ore first produced came principally from the Coastal Plain bog iron deposits. The industry spread westward until today the only ore produced comes from the extreme western part of the

State, chiefly from Avery County. A great deal of iron ore has been shipped from Cherokee County during the past few years. However, no production has been reported from the county during 1927 and 1928.

The iron ores of the State include all of the chief iron bearing minerals, as magnetite (the magnetic oxide of iron), hematite (the red oxide), limonite (the yellow oxide), and the bog iron ores. At a few places siderite or spathic iron ore occurs but no deposits of commercial importance have been found.

The principal magnetic iron ores occur in Granville, Stokes, Surry, Catawba, Ashe, Avery and Mitchell Counties. Probably the most important deposits of this ore occur in Avery and Mitchell Counties. The hematite ores are confined to Ashe and Granville Counties. The limonite ores occur chiefly in Chatham, Gaston, Madison and Cherokee Counties; the most important deposits occur in Cherokee County. The bog ores occur chiefly in the Coastal Plain area. Other than the above ores, titantic magnetites occur but none of much promise have been found.

In 1910 the State Geologist was called upon by *The Manufacturers Record* to give an estimate of the iron ores of this State not controlled by corporations. Below is the estimate given by Dr. Joseph Hyde Pratt of what is termed "present supply." "Present supply" meant the amount of ore which could have been worked then while the price was low.

Magnetite	6,650,000 tons
Titanic magnetite	1,510,000 tons
Hematite	250,000 tons
Limonite	725,000 tons

Below is the "future supply," the ore which can be worked when the price of iron and other conditions are such as to warrant it. In the estimate an arbitrary depth of 100 feet was taken.

Magnetite	8,975,000 tons
Titanic magnetite	1,300,000 tons
Hematite	900,000 tons
Limonite	5,000,000 tons

Considerable interest has been shown in the magnetic iron ore deposits of Avery and Mitchell Counties during the past summer. Some of the large steel and steel-alloy companies have had engineers in the field looking for a low phosphorous, low titanium, high metallic iron ore suitable for high grade steels. It is reported that the magnetic ores of several of the western counties meet these requirements. However, a great many of the deposits are rather inaccessible, consequently the future development is uncertain.

High grade magnetic ores have been found in several of the western counties. The ores in Avery County are noted for their low content of phosphorous and sulphur. They differ from the titaniferous magnetites in their low content of TiO_2 and in the absence of $Cr_2 O_3$. The chief districts where high grade ores occur are in a belt from Cranberry, Avery County, to the southwest through Mitchell County. The most important prospects are the Cranberry; Lee Johnson place, between Vale and the Cranberry mine; the Cooper place, three-quarters of a mile south of Elk Park; Ellers and Hardigraves, one mile southwest of Elk Park; Wilder mine, in Carter County, Tennessee; Red Rock mine, on west side of Morgan Creek, one-half mile south of East Tennessee and Western North Carolina Railroad; Patrick mine, one mile further west; Teegarden and Ellis mines, three-quarters of a mile southeast of Shell Creek; Peg Leg and Old Forge mines, on divide between Hampton Creek and Doe River; Horse Shoe, Julian and Campbell prospects; Chestnut Ridge and Magnetic City prospects; and deposits between Magnetic City and Toe River. These prospects are all in the Cranberry belt in Avery and Mitchell Counties and Carter County, Tennessee. In Madison County, on the same lead, is the Big Ivy mine. Here the vein is 98 feet thick and can be traced a considerable distance.

In Ashe County there are a number of outcrops of high grade magnetite in a belt extending from Little Horse Shoe Creek northeast into Virginia. There are listed on this belt 19 mines and prospects. In the northwest section of the county there is another belt on which five outcrops are found. The ores of these belts are high in silica, low in phosphorous, sulphur and titanium. The iron content runs from 43 to 68 per cent.

There are also several outcrops of magnetites in Alleghany, Catawba, Gaston, Jackson, Lincoln, and Yancey Counties.

PRODUCTION OF IRON IN NORTH CAROLINA 1923 TO 1928, INCLUSIVE

YEAR	TON,	VALUE	VALUE PER TON
1923	59,684	$161,603.	$2.70
1924	12,525	32,512.	2.58
1925	22,011	49,511.	2.25
1926	15,198	31,645.	2.08
1927	32,528	81,753.	2.51
1928	*	*	*

*No Production.

As shown by the above table, the production of iron for 1927 showed an increase of 17,330 tons and $50,108 in total value. The price per ton increased 43 cents which is probably the cause of the increase in tonnage. The production came from the Cranberry Furnace Company, Cranberry, N. C.

MANGANESE

During the years 1927 and 1928, no production of maganese ore was reported. However, at two or three localities, especially in Transylvania County, prospecting was done. With the price of manganese ore increasing, it is possible that some of the most promising localities will show a production in the near future.

The location of the manganese deposits which show some promise are given as follows, by counties:

Near Sparta, in Alleghany County, a very good grade of manganese ore occurs. In a belt extending from Little Horse Shoe Creek, northwestward to the Virginia line in Ashe County, the magnetic iron ores contain high percentages of manganese. In Caldwell County, just west of Lenoir, manganese ore has been found but little prospecting has been done. About two and one-half miles above the mouth of Low Creek in Cherokee a very pure manganese ore (pyrolusite) occurs averaging 58.36% manganese. Near Kings Mountain, in Cleveland County, a 1,000-foot seam of low grade manganiferous slate occurs. In Madison County, on the east side of Shut-In Creek

a four-foot seam of good manganese ore occurs. In the western part of Surry County a very good manganese ore is found. Near Brevard in Transylvania County a very high grade (58% manganese) manganese ore is found. Some prospecting has been done recently in this area.

TIN

The tin deposits of the Carolinas are confined to a narrow strip of territory extending from Gaffney, South Carolina, in a general northeasterly direction to Lincolnton, North Carolina. The principal deposits that have thus far been prospected are the Ross mine at Gaffney, South Carolina; the deposits in the vicinity of Kings Mountain, North Carolina, on the southern end of Chestnut Ridge, about two and one-half miles northeast of Kings Mountain; on the old John E. Jones plantation, seven miles northeast of Kings Mountain.

The rocks of the area are chiefly crystalline schists and gneisses, the former being micaceous, chloritic and argillaceous, and the latter micaceous and hornblendic. The general strike of the schistosity of the rocks is in a northeasterly direction and the dip at steep angles to the westward. The tin ore occurs in the so-called greisen veins which are for the most part in the mica schist adjoining the gneiss. The greisen veins are for the most part lense shaped. The tin-bearing mineral is cassiterite, $Sn\ O_2$, and contains theoretically 78.6 per cent of metallic tin.

The deposits of tin have been known for many years, since 1883, but no real systematic prospecting has been carried on until recently. The percentage of cassiterite in the dikes is rather low.

About one-half mile to the south of Kings Mountain, the North Carolina Mining Company, Inc., has been doing considerable prospecting. Several acres of land along the outcrop of the vein have been tested rather thoroughly and show from one to two per cent cassiterite to a depth of three feet. Two shafts have been sunk on the west vein, one to a depth of 150 feet and the other to a depth of 75 feet. It is reported that the vein (greisen) at these places is six feet wide and contains about three per cent cassiterite. It is the intention of the

company to cross-cut to the east vein as well as to tunnel the west vein at various levels.

A small hoisting machine has been installed to hoist the ore. Near by a small concentrating plant has been built which has a daily capacity of 20 tons of ore. The plant consists of a crusher, log washer or disintegrator, screens, and wilfley tables. The product consists of almost pure cassiterite which carries about 70 per cent tin. There are three grades to the product, fine, medium and coarse.

Near Lincolnton the Carolina Tin Company has been doing considerable prospecting to determine the value of the tin deposits on the Jones property. The developments so far have been confined principally to one locality. A shaft has been sunk to a depth of 105 feet and tunnels have been sent out at three levels, 50, 70 and 105 feet. About 1,000 feet of tunneling has been done. All of the material taken from the shaft and tunnels has been milled and the concentrates shipped. It is reported that the ore averages from one to two per cent tin.

The vein on this property is about 60 feet wide and can be traced for several hundred feet. The greisen which contains the highest per cent of cassiterite is on the hanging wall side. On the foot wall side the vein is composed chiefly of kaolin clay, mica and some greisen material. At this particular place it seems that the clay and mica could be recovered as well as the tin ore. Since the vein dips at about 70° or 80° angle it could not be worked to any great depth for clay and mica.

ABRASIVE MATERIALS

The chief abrasive materials found in North Carolina are corundum, garnet, spinel and millstone. During the year 1927 the only abrasive material produced was a small quantity of millstones. This came principally from the Salisbury granite district.

Corundum occurs at a number of localities in the western part of the State. The chief occurrences are listed as follows: near Democrat and Swannanoa Gap in Buncombe County associated with the peridotite dikes in that area; one mile south of

Elf, on Chunky Gal Mountain and at the head waters of Muskrat Creek in Clay County; as loose fragments at Addie, on Caney Fork, John's Creek, and near Glenville and Sapphire in Jackson County; on Hickory Knoll Creek, near Ellijay and Cullasaja, on the summit of Turkey Knob and in the gravels of Cowee Creek in Macon County; about three miles below Marshall, Madison County, the place where the mineral was first mined in the State.

Garnet suitable for the abrasive trade occurs as follows: near Chunky Gal Mountain, Clay County; near Willets, in Jackson County, in a high grade rhodolite garnet schist; three miles north of Franklin, Macon County, is a schist.

The spinels occur chiefly in Clay and Macon Counties in the Yellow Mountains associated with the peridotites and dunites.

ASBESTOS

The minerals which have been mined and sold under the name asbestos, include: Actinolite and Anthophyllite, the amphibole, and Chrysotile, the fibrous form of serpentine. Asbestos occurs in three different ways: (1) cross fiber, fibers transverse to walls, which is usually the chrysotile and rarely anthophyllite; (2) slip fiber, fibers parallel to walls, which is either chrysotile or amphibole; and (3) mass fiber which has the fibers in bundles or groups.

In this State the amphibole, chiefly anthophyllite, is the most important variety found. The chief occurrences are as follows: in the southwest section of Ashe County; along the North Toe River four miles from Minneapolis in Avery County where the largest deposit in the State is found; in Caldwell County near the old Baker mine; near Norton and on Cimmissioner Creek in Macon County; the amphibole, anthophyllite and fibrous enstatite near Ledger and Bakersville; in Yancey County on the southside of Green Mountain and two miles to the northeast of Micaville.

Two plants have been built in the State, one at Minneapolis in Avery County and the other at Norton in Macon County. Both plants have been operated only on a very small scale due

to the limited market. In spite of this fact two other plants are under consideration in Yancey and Mitchell Counties. It is doubtful, however, that either will be built in the near future.

The uses of asbestos are numerous but the usefulness depends mainly on the flexibility of its fibers and fibrous structure and to some extent on its low conduction of heat and electricity as well as on its moderate refractoriness. The variety mined in North Carolina is used in fire-proof paints, boiler coverings, for packing in fire-proof safes, and for electrical insulation where heat resistance is necessary. The best grade is used also for filtering in chemical work. There are many patent mixtures of asbestos and other materials, such as Portland cement, now used for making products as asbestos wood, asbestos slate, asbestolith, corrugated roofing tile, roofing felt, and flooring in offices and railway pullman and chair cars. It is reported that as a result of these several comparatively new uses the demand is increasing annually.

BARYTES

Barite, or barytes, as it is known commonly, a sulphate of barium ($BaSO_4$) is a heavy white crystalline mineral with a perfect prismatic cleavage and is found rather widely distributed in nature. It does not usually occur in well-defined veins but is more often found in a series of pockets or lenses of varying dimensions. These are more or less in line, often filling the dip of the rock with which they are associated, which in most cases is limestone. In some instances the rock is entirely decomposed and the pockets of barytes occur in clay. A mineral commonly associated with barytes is galena, a lead sulphide. On account of the alteration of the rocks with which the barytes is associated, it is usually more or less iron stained so that it is often necessary for the barytes to be ground, washed, and bleached with acids in order to purify it. Some, however, is found of sufficient purity so that it does not need any washing or bleaching whatever.

The uses for barytes are somewhat varied, but by far the greater part of this mineral produced is used in the manufac-

ture of mixed paints, in the ground, or ground, floated, and bleached condition. It has a permanently pure white color, unaffected by the weather or by causes which in most cases will blacken white lead; but on account of its crystalline nature it is too transparent to be used alone as a white pigment. It is used, however, in mixed paints with either white lead or zinc white, or a combination of both. One very white pigment, which is composed partly of barytes, is lithopone, which is especially adapted for interior use in enamel and wall finishes. *Blac Fixe* is a precipitated form of barium sulphate which is used as a base on which lake colors are precipitated. It is also employed in the manufacture of wall paper, rubber, and in tanning leather.

The principal barytes deposits of North Carolina are in Madison County in the vicinity of Marshall, Stackhouse, Sandy Bottom and Hot Springs; and in Gaston County, about five miles from Bessemer City. North Carolina barytes is of good quality and occurs in considerable quantity. There has been no production in this State during the past few years.

CEMENT PRODUCTS

During the year 1927, the cement products industry in the State showed a substantial increase over that of the previous years. The industry becomes more and more important each year. North Carolina only produced the sand, stone screening and gravel or crushed stone for such materials. The cement is brought in from other States, principally from Pennsylvania and Tennessee. The most important cement products produced in 1927 are concrete blocks, concrete brick, culvert pipe, and septic tanks.

The total production of each is given below:

	1927
Concrete Blocks	$237,199
Hollow Building Tile	231,828
Culvert Pipe	156,642
Miscellaneous	10,803
	$636,472

PRODUCERS OF CONCRETE PRODUCTS IN NORTH CAROLINA IN 1927

Name of Producer	Address	Town	County
Anson Brick & Tile Company	Lilesville	Lilesville	Anson
Craftstone Company	Box 857	Asheville	Buncombe
J. H. Roberts	94 Mt. Clare Ave.	Asheville	Buncombe
Southern Mac. Tile Company	32 N. Lexington St.	Asheville	Buncombe
Stone, Tile Manufacturing Co.	Box 1525	Asheville	Buncombe
P. S. Ninus Concrete Pipe Co.	Spartansburg, S. C	Biltmore	Buncombe
Smith & Fairchild	West Asheville	West Asheville	Buncombe
L. A. Arrowood	Shelby	Shelby	Cleveland
H. A. Hackney	New Bern	New Bern	Craven
A. L. Leonard & Sons Brick Co.	Route 1	Lexington	Davidson
Leonard's Brick & Concrete Works	Route 1	Lexington	Davidson
Lexington Brick & Block Works	Lexington	Lexington	Davidson
Gray Concrete Company	209 Randolph St.	Thomasville	Davidson
Linder Hy-Test Tile Company	Box 315	Durham	Durham
Concrete Products Company	215 Trade Street	Winston-Salem	Forsyth
C. A. Crews	418 Arcadia Street	Winston-Salem	Forsyth
Piedmont Septic Tank Company	Winston-Salem	Winston-Salem	Forsyth
Newman's Concrete Works	Hendersonville	Hendersonville	Henderson
Trinity Concrete Products Co.	Kinston	Kinston	Lenoir
J. Clyde Arrowood Concrete Plant	Lincolnton	Lincolnton	Lincoln
Carolina Concrete Pipe Co.	Box 815	Charlotte	Mecklenburg
Duntile Cement Products Co.	Box 521	Charlotte	Mecklenburg
Ornamental Stone Company	Charlotte	Charlotte	Mecklenburg
Southern Brick & Tile Co.	Charlotte	Charlotte	Mecklenburg
Cement Products Company	Wilmington	Wilmington	NewHanover
Reidsville Concrete Construct. Co.	219-227 N. Scales St.	Reidsville	Rockingham
Halley Concrete Works	Albemarle	Albemarle	Stanly
Edgerton Concrete Products Co.	Kenly	Kenly	Johnston

CLAYS

KAOLIN

All of the kaolin clay deposits of this State which are being developed commercially at the present time occur in the mountain section principally in Mitchell, Yancey and Macon Counties. The chief center of production is Spruce Pine and vicinity where five deposits are being worked.

The kaolin deposits of the mountain district are of the residual type which are the result of the weathering or decay of pegmatite dikes or coarse grained granites. North Carolina has long been the leading producer of residual kaolin or china clay in the United States. It is used chiefly in making china, porcelain and semi-porcelain ware, as well as spark plugs, glass-melting pots and different types of tile. Its chief use in the body is to serve as a bond.

MITCHELL COUNTY

The Harris Clay Company, the leading producer in the State, operates three plants in this county, one at Spruce Pine known as the Spruce Pine mine, one at Penland known as the Penland mine, and one two miles west of Spruce Pine on the north side of North Toe River known as the Sparks mine. These plants produce a high grade finished product all of which is shipped to the principal pottery producing centers.

The Norman G. Smith Company is operating a modern washing plant at Spruce Pine. This plant was sold recently to the Harris Clay Company. A new washing process has recently been installed which is described briefly below:

The method which this company has introduced is entirely mechanical. The clay is washed from the clay pit as before with a hose. No settlings, washers, or beaters are used. No men are required to shovel sand. A bowl classifier accomplishes all of these operations in one.

This bowl classifier consists of a settling bag in the form of an inclosed trough, with the upper end open, in which are placed mechanically operated rakes or scrapers for the purpose of removing the quick settling material from the open end.

Each rake is carried by two hangers, one at the sand discharge end suspended from an arm attachment to a rocker arm or lever, which terminates in a roller, the other from the bell-crank which is connected by a rod to the same rocker. The roller is pressed against a cam on the crank shaft. The rakes are lifted and lowered at the opposite ends by the action of the cam transmitted through the rocker arms and bell-cranks, and the horizontal motion is obtained directly from the crank.

Upon the lower side of this acting box is superimposed a broad shallow steel bowl 22 feet in diameter, with stirring or thickening mechanism.

The thickening is accomplished by the same principal as the settling of the sand in the troughs. Revolving arms, to which plow blades are attached, sweep the bottom, pushing the quick settling solids toward a central opening through

which they fall to the bottom of the main classifier tank, and are subject to the action of the rakes. The feed enters the bowl through a shallow feed well near the center.

Wash water is introduced near the center of the main tank and flows center-current to the solids, up through the central opening of the bowl. The clay is overflowed into a peripheral launder around the rim of the bowl. The sand and other impurities are carried out by the rakes. It is obvious that the action of the plows and the rakes, together with the center flow of the wash water, will produce a very complete washing and separation.

The bowl mechanism is operated by a light belt from an extension of the main drive shaft. The power is negligible. The plow arms are usually revolved at from one-half to eight revolutions per minute, according to the load of solids handled, and classification desired.

The classifier used is manufactured by the Dorr Classifier Company which makes classifiers for the chemical and metallurgical industries which include hundreds of the leading industrial companies of the world. A special machine was built for this trial with the clay.

When the clay leaves the classifier, it is run through the filter process, is dried and ready for shipment. The clay, in going through the process, is ready for shipment much earlier and is a more uniform and better product than that produced by the old sand trough method.

YANCEY COUNTY

The Harris Clay Company operates two plants in this county, one near Lamoti and the other near Lundy. The Lundy mine is one of the largest in the State. The clay from this plant is troughed to the plant near the railroad where it is washed and dried.

About two miles to the east of Burnsville is the Pollard Clay Company's plant. The clay deposit here is one of the purest in the State. The process for washing at this plant is quite different from any other in the State. It consists of

crusher and sand trough, 80-mesh screen and sand trough, 150-mesh screen and then to settling pool.

There are no mines operating as clay mines in any of the other counties, but in Macon County near Franklin a large amount of clay is recovered from a mica mine.

W. S. Bayley estimated in 1918 that there was a reserve of 400,000 tons of kaolin in Yancey and Mitchell Counties that could be mined commercially. Mr. Enloe, of the Harris Clay Company, estimates that there are some 100 deposits of clay in Macon, Jackson and Swain Counties. However, most of these are small and a great distance from the railroad.

Other properties which have been worked or which may offer future possibilities are listed by counties below:

HAYWOOD COUNTY

There are only two properties in this county which are well known, the Woodrow property, one mile southeast of Woodrow, and the Herren prospect, about four and a half miles south of Waynesville.

HENDERSON COUNTY

Between Etowah and Fletcher along the French Broad River most of the valley is underlain with white clay to a depth of 10 feet or more. This clay may have originated from the underlying Henderson granite. A buff-burning clay near Etowah is now being used by the Moland-Drysdale Brick Company for the manufacture of buff face brick. This is the only plant in the State producing such brick.

JACKSON COUNTY

There are five prospects and mines in this county: the Hogback mine, four miles southeast of Dillsboro; the Rhonda mine, seven and one-half miles southeast of Dillsboro near the mouth of Caney Creek; the Ashe and Harris prospects near Webster, and the Ross prospect near Beta.

MACON COUNTY

In this county there are five kaolin mines and prospects: the Iotla mine, four miles north of Franklin near the Iotla

Bridge where some clay is being saved from the mica; Porter prospect, four miles northwest of Franklin on Iotla Creek; the Johnston property one mile northwest of Franklin on Tremont Mountain, and the Cunningham property near the Johnston.

SWAIN COUNTY

There are several outcrops of clay in this county. The most important found so far are the Payne and Sullivan mine, four miles southwest of Bryson City, and the Hewitt mine, two miles east of Almond.

There are several small deposits of clay in the Piedmont section, one or two of which have been worked in the past. These occur chiefly in Richmond, Montgomery, Moore, Randolph, and Granville Counties. The clays in these counties seem to be a weathered volcanic ash rather than the true kaolins. The texture and composition of these materials vary greatly in different places in the same deposits.

Production

The production of kaolin clay in 1927 amounted to 20,384 tons valued at $327,688, or a decrease of 371 tons in quantity and $3,799 in value. The price per ton increased from $16.00 to $16.10. The kaolin was used principally in the manufacture of pottery, enamel and in the paper trades.

PRODUCTION OF CLAY (KAOLIN) IN NORTH CAROLINA IN 1927
BY COUNTIES

County	Tons	Value
Macon	1,015	$ 16,920.
Mitchell	13,153	212,062.
Yancey	6,166	98,656.
Undistributed	50	50.
Total	20,384	$327,688.

PRODUCTION OF KAOLIN IN NORTH CAROLINA
FROM 1923 TO 1928, INCLUSIVE

Year	Amount (tons)	Value	Average Price per Ton
1923	23,793	$369,518	$15.55
1924	16,966	277,526	16.34
1925	18,649	319,599	16.60
1926	20,719	331,487	16.00
1927	20,384	327,688	16.10
1928	19,898	298,951	15.00

During 1928 there were nine plants in operation distributed among four producers and three counties, Mitchell leading with three producers and four plants.

PRODUCERS OF KAOLIN IN NORTH CAROLINA
IN 1928

Name of Company or Producer	Address	Plant Location	
		Town	County
Franklin Mineral Products Company	Franklin	Franklin	Macon
General Mica & Clay Company	Franklin	Iotla	Macon
Harris Clay Company	Dillsboro	Spruce Pine	Mitchell
Penland Feldspar & Kaolin Company	Penland	Penland	Mitchell
Norman G. Smith Company	Spruce Pine	Spruce Pine	Mitchell
Harris Clay Company	Dillsboro	Grundy	Yancey
Pollard Clay Company	Burnsville	Burnsville	Yancey

The Harris Clay Company, the chief producer, operated five plants in 1927 and 1928 located in Mitchell and Yancey Counties.

BRICK AND TILE CLAYS AND SHALES

By A. F. Greaves-Walker, *Ceramic Engineer, State College*

DISTRIBUTION

North Carolina is rich in clays and shales suitable for the manufacture of structural clay products such as face brick, common brick, hollow building tile, roofing and floor tile and sewer pipe. Practically every county in the State has clay deposits which will at least make common brick, although some of the resulting products will not measure up to the quality demanded by present day constructors for large building projects.

The most valuable deposits are the pre-Cambrian shales which outcrop in a wide belt traversing the State through the Piedmont section, the Triassic shales which outcrop in a narrower belt along the lower edge of the Piedmont and in the Dan River area; the Brevard schist of Cambrian age and secondary kaolins which occur in the French Broad Valley in Henderson County and the Cambrian shales in Madison County.

During the past few years all of the development of the structural products industries has taken place in the shale and schist areas. Indications point to a continuance of further development in these areas as against those in which only surface or flood plain clays are available. Because of this fact investigation of the resources suitable for the manufacture of structural products has been confined almost entirely to the sections in which the shales and schists occur.

In a number of counties in which outcrops of the pre-Cambrian or Triassic formations occur no development has taken place due to the material being unsuitable for manufacturing purposes or the lack of railroad facilities. Transportation facilities in close proximity to a clay or shale deposit is a primary pre-requisite.

Fortunately for the North Carolina manufacturer all of the shales and schists finish at low temperatures as compared with competent materials in adjoining States. This gives an important cost advantage.

PRE-CAMBRIAN SHALES

The pre-Cambrian rocks outcrop over a very large area but only over a relatively small part of this area are the exposures sufficiently softened by weathering action to be suitable for the manufacture of clay products. It is principally in the southern part of the State that the old "slates" have been weathered to the extent of developing plasticity when processed. Most of the outcrops are still hard enough to require crushing but a few are found which do not. These shales burn to a good hard body at from 1800° to 1950°F with a total linear shrinkage of 10% (average). They produce fine red colors and can be flashed (reduced) to a wide range of

browns, purples and blacks. The burning range is usually rather short and care is necessary to prevent overburning. The shales are particularly suitable for face and common brick.

TRIASSIC SHALES

The exposures of Triassic shale, both along the base of the Piedmont, south of Durham and in the Dan River area are generally suitable for clay products manufacture. Occasional strata of sandstone which must be eliminated occur in both areas. In the Deep River area pockets of gravel sometimes are encountered and in the Dan River area strata of low fusion shale. These must also be eliminated in mining.

These shales finish to a good hard body at from 1850° to 1950°F. The red colors produced are good, the shales in the Dan River area, however, giving a somewhat deeper shade than those of the Deep River area. Flashed colors from light brown to black are readily obtainable. The burning range is wide enough for safety. The total linear shrinkage is approximately 10% (average).

These shales have proven adaptable for face brick, common brick, hollow building tile, salt glazed sewer pipe, drain tile, roofing, chemical brick and rings and floor tile. They are unusually soft and easily worked.

BREVARD SCHISTS

The Brevard schists finish to a good red color at from 2000° to 2150°F with a total linear shrinkage of approximately 12% (average). They are not highly plastic and, therefore, have rather low bonding strength. They produce a full range of good flashed colors from brown through purple to black. The burning range is wide and safe.

They have been proven adaptable for the manufacture of face and common brick, hollow tile and roofing tile.

SECONDARY KAOLINS

The secondary kaolins of the French Broad valley are sufficiently contaminated with iron to produce buff and gray colors. Several areas have been discovered in which the iron content

is low enough to permit their use in ivory tinted white ware bodies. In these bodies they are substituted for ball clay.

These kaolins vary considerably in free quartz content but are always sufficiently plastic to be workable in stiff mud machines.

They finish to a good buff body at from 2200° to 2350°F and under reducing conditions produce a good gray at the same temperatures. The total linear shrinkage is approximately 12% (average). The burning range is very wide.

These clays are adaptable to the manufacture of face brick, second quality fire brick, hollow tile, flue lining and pottery.

CAMBRIAN SHALES

These shales, outcropping near Hot Springs in Madison County, have been used from time to time for the manufacture of common brick.

They have excellent working qualities and finish to a good red body between 1900° and 2000°F. They flash to a full range of colors from brown to black and have a good burning range. They are suitable for face and common brick.

DISTRIBUTION OF PLANTS AND DEPOSITS BY COUNTIES

In the following counties structural clay products plants are in operation at the present time (1928) or raw materials are available which investigation has shown gives promise of future development:

ALAMANCE

Two plants are located in this county, one at Mebane, operated by Trolinger and Montgomery, and one at Graham, the W. T. Jeffries plant. Both plants manufacture common brick and use surface clays.

Practically the entire southeast half of this county is underlaid with pre-Cambrian rocks, the softer of which have weathered near the surface so as to be workable. There is a possibility of the further development of these weathered materials near the line of the Southern Railway.

ANSON

No plants have been established in this county but both the pre-Cambrian and Triassic shales outcrop along the Sea-

board Air Line between the Union County line and Wadesboro. The shales are weathered and easily workable for some distance below the surface.

BEAUFORT

The W. T. Boyd plant is located at Washington. This plant manufactures common brick from flood plain clays.

BERTIE

The Aulander Brick Company is located at Aulander. This plant uses flood plain clays for the manufacture of common brick.

BURKE

The Duckworth Brick Company is located at Morganton, using surface clays for the manufacture of common brick.

CABARRUS

The Peerless Brick Company operates at Concord, manufacturing common brick from surface clays.

The pre-Cambrian outcrops along the eastern edge of the county but the only development which can take place is in the southeastern corner where for a few miles the Norfolk-Southern Railroad crosses the outcrop.

CALDWELL

Powell Brothers operate a plant at Lenoir, using surface clays for common brick.

CHATHAM

Two plants operate in this county. The common brick plant of the Cherokee Brick Company at Brickhaven uses the flood plain clays of the Cape Fear valley and the Carolina Fireproofing Company's plant at Gulf, one of the two modern hollow tile plants of the State, uses the Triassic shales with some surface clay.

Practically the entire county is underlaid with pre-Cambrian and Triassic shales. Promising exposures of the latter occur at a number of points along the Seaboard Air Line between Merry Oaks and Moncure. Outcrops along the Norfolk-Southern Railroad in the eastern and the Southern Railroad

in the western part of the county give promise of future development.

CLEVELAND

Carpenter and McGill operate a common brick plant at Kings Mountain, using decomposed schist. The decomposed schists of the Kings Mountain district give greater promise of usefulness than most clays of this type, although they are generally suitable for common brick only.

COLUMBUS

Two plants operate in this county. The plant of the Roger Moore's Sons Company at Acme manufacture face and common brick and hollow tile from a flood plain clay of good quality. A. F. Powell manufactures common brick at Whiteville from flood plain clays.

The deposits of flood plain clay in the eastern end of this county along the Atlantic Coast Line and Seaboard Air Line are above the average in physical qualities for this type.

CRAVEN

The Clark Brick and Tile Company at Clark, the W. P. Rose Company at Hyman's and the Stevenson Brick Company at New Bern produce common brick from flood plain clays.

CUMBERLAND

The E. A. Poe Brick Company at Fayetteville and the Ideal Brick Company at Slocomb operate common brick plants, using flood plain clays.

DAVIDSON

The plant of the Cunningham Brick Company at Shale Brick, near Thomasville, is one of the newer plants in the State. The product is face brick made from pre-Cambrian shale which is exposed at numerous points over the southeastern section of the county.

At Denton, L. A. Smith & Sons manufacture common brick from the decomposed surface of the shale outcrop.

The High Point, Thomasville and Denton Railroad traverses the area underlaid with shale and it is along this line that any future development will take place.

DURHAM

One plant owned by Belvin & Cheek is located at Durham. This plant manufactures common brick from weathered Triassic shale.

The entire county is underlaid with the pre-Cambrian and Triassic formations in about equal proportions. Only the Triassic, however, appear to offer possibilities for future development. These shales are sometimes very sandy in this section, in fact approach the sandstone phase. At other points pockets of gravel are found irregularly bedded with plastic shale. Any developments will probably take place along the Southern Railroad and Durham and Southern Railroad south of the city of Durham.

FORSYTH

R. F. Byerly and Hedgecock and Hine operated common brick plants, using flood plain clays, at Winston-Salem.

The Triassic shales of the Dan River section outcrop over a very small area in the northeast corner of the county. Both the Norfolk & Western Railroad and the Southern Railroad cut through this area.

GASTON

The Kendrick Brick and Tile Company at Mt. Holly and J. W. Harrison at Lowell operate common brick plants which use flood plain clays.

In several sections of this county outcrops of weathered schist suitable for the manufacture of common brick are found. Any developments will probably take place along the several railroads which pass through the county.

GUILFORD

The largest ceramic plant in the State, the Pomona Terra Cotta Company, at Pomona, is located in this county. However, all of the raw material used for the manufacture of salt glazed shale sewer pipe, flue lining, drain tile and hollow tile is shipped from Rockingham and Chatham Counties. No deposits of clay or shale giving promise of commercial development appear to be available.

HALIFAX

Three plants manufacturing common brick are located in this county. The largest is at Weldon, the Grant Brick Works, which uses a flood plain clay consisting largely of decomposed pre-Cambrian shale. The other two, the W. E. Smith & Brothers plant and the W. L. House plant, are at Scotland Neck. Both of these plants use an estuary clay of good quality.

Pre-Cambrian shales outcrop at several points in the county, the principal areas being located near Halifax and in the Roanoke River valley on both sides of Weldon. The two latter areas are traversed by the Atlantic Coast Line and the Seaboard Air Line. The area around Weldon is especially favorable to development.

HARNETT

The Lillington Brick Company operates a common brick plant at Lillington, using a flood plain clay.

Southeast of Lillington the pre-Cambrian shales outcrop along the Cape Fear River. There is also an outcrop north of Spout Springs in the eastern part of the county. Near Lillington, the shales are soft enough to be worked although the plasticity is low due to high silica content. There are possibilities of future development in this area.

HENDERSON

One plant manufacturing red and buff face brick and roofing tile and a number of plants making common brick are located in this county. The plant of the Moland-Drysdale Corporation at Etowah uses decomposed Brevard schist for red face brick and roofing tile and a secondary kaolin for buff face brick. The plant is of modern design and incorporates some features not found in other plants of the State. At Brickton, the D. S. Hildebrand plant uses the secondary kaolin for making common brick, as does the Sherrill Brick Company. At Fletcher, the Fletcher Brick Company uses the decomposed Brevard schist for common brick.

No county in the State has deposits of clay suitable for the manufacture of high grade structural products which ex-

ceed in value those of Henderson. The Brevard schist, which produces excellent red colors, is available at numerous points along the Southern Railroad. The secondary kaolin, which also occurs along the French Broad River and close to the Southern Railroad, is present in considerable quantities.

IREDELL

The Statesville Brick Company operates a common brick plant at Buffalo, using flood plain clay, and also a plant at Statesville which uses clay shipped from Buffalo.

JOHNSTON

Three plants manufacturing common brick and using flood plain clays are located in this county. The Selma Brick Company is located at Selma, the Meadow Brick Company at Four Oaks and Sanders and Beasley at Smithfield. Pre-Cambrian shale, which is low in plasticity but suitable for brick manufacture, outcrops in the Smithfield-Selma area. This relatively small outcrop is crossed by both the Atlantic Coast Line and Southern Railroad. Another outcrop occurs along Buffalo Creek in the northeastern section which is crossed at one point by the Atlantic Coast Line.

LEE

A large part of this county is underlaid with the Triassic shales. On these shales, which reach their best qualities in Lee, a number of modern plants have been built in the past few years. The Sanford Brick and Tile Company at Colon, the Shale Brick Company at Colon and the two plants of L. E. Isenhour at the same place all use the shale of manufacturing common brick.

At Sanford the Borden Brick and Tile Company has a modern plant using shale for the manufacture of hollow building tile and face brick. The county is crossed by a network of tracks of the Southern, Atlantic and Western, Seaboard Air Line and Norfolk-Southern railways which offer splendid opportunities for future development.

LENOIR

The Moseley Brick and Shingle Company operates a common brick plant at Kinston which uses a flood plain clay.

MONTGOMERY

At Mt. Gilead, the Mt. Gilead Brick Company operates a plant which uses pre-Cambrian shale for making common brick. At Star, the T. L. Manness plant uses the decomposed surface of the shale for common brick manufacture.

The entire county, with the exception of the extreme southeast corner, is underlaid with pre-Cambrian shale. A small area of Triassic outcrops along a section of the south boundary. Future development is most likely to take place along the Norfolk-Southern Railroad in the southwest portion of the county where the shales are particularly suitable for structural clay products manufacture.

MOORE

No plants are located in this county, but more than half of it is underlaid with the pre-Cambrian and Triassic formation, in which some very promising shales occur. The area around Glendon on the Norflok-Southern offers promise of future development. Small deposits of buff burning kaolinized volcanic ash are also found scattered throughout the county.

MECKLENBURG

No plants are located in this county. As yet no promising deposits of shale or clay have been developed.

MADISON

No plants now operate in this county, although two were formerly located at Hot Springs. Although these plants were not successfully operated, the Cambrian shale which outcrops in this area, in close proximity to the Southern Railroad, is of good quality and can be successfully worked for structural products.

NASH

The Nash Brick Company operates two plants at Rocky Mount, both making common brick from a flood plain clay which is largely weathered shale.

Pre-Cambrian formations outcrop in several localities over small areas. One of these outcrops is along Stoney Creek in the central portion and the others in the Tar River valley and along the Moccasin Creek in the south portion. The shales are sandy, soft and workable. The Atlantic Coast Line just touches the Stoney Creek area in the vicinity of Nashville and the Norfolk-Southern Railroad the Moccasin Creek area, east of Zebulon. The latter area offers splendid possibilities for development.

In this county there are also deposits of kaolinized volcanic ash of considerable size which, while not uniform in quality, offer possibilities as ceramic raw materials and as a substitute for Fuller's Earth. Some of these deposits occur along the Atlantic Coast Line in the Nashville area.

PASQUOTANK

At Elizabeth City a plant operated by the Elizabeth City Brick Company manufactures common brick from flood plain clay.

PENDER

W. H. Booth operates a plant at Burgaw, using flood plain clay for the manufacture of common brick.

PITT

The Dail Brick Works at Greenville operates a common brick plant, using flood plain clay.

RANDOLPH

Hayworth and Davidson, and O. E. Rich operate plants at Asheboro, making common brick from surface clay, as does the Glenola Brick Company at Glenola. The clays used are largely weathered pre-Cambrian shales.

This entire county is underlaid with pre-Cambrian rocks, some being weathered sufficiently for clay products manufacture. Any future development would naturally take place along the Norfolk-Southern Railroad.

ROBESON

At Rowland, W. C. Bracey operates a common brick plant, using flood plain clay.

ROCKINGHAM

The J. M. Hopper Construction Company operates a plant at Leaksville which uses weathered Triassic shale for manufacturing common brick.

Running diagonally across this county from southwest to northeast is a fairly wide outcrop of Triassic shale. Mines at Madison have for years past supplied this shale for the manufacture of sewer pipe and other hollow goods at the plant of the Pomona Terra Cotta Company.

The shale is available in quantities along the Southern Railroad from Madison south and along the Norfolk & Western from Madison to Pine Hall. There are also possibilities along the Danville and Western in the northern part of the county.

ROWAN

G. W. Isenhour Brothers operate a common brick plant, using flood plain clay, at East Spencer.

RUTHERFORD

At Bostic, the Bostic Brick Company operates a common brick plant, using flood plain clay.

RICHMOND

Outcrops of pre-Cambrian shales of promise are found on the western limits of the town of Rockingham near the Seaboard Air Line. A considerable portion of the western half of the county is underlaid with pre-Cambrian shale formations of good quality.

SAMPSON

D. W. Dowdy operates a common brick plant at Roseboro, using flood plain clay.

STANLY

Two modern face brick plants using pre-Cambrian shales are located in this county. The Carolina Shale Brick Company

operates a plant at Norwood and the Yadkin Brick Company one near New London. Both plants produce a wide variety of good colors.

The entire county is underlaid with pre-Cambrian shales and slates, a very large proportion of which offers possibilities of future development. The distribution of the lines of the Southern and the Winson-Salem Southbound Railroad makes a large part of the shale in the county available.

STOKES

Two modern plants using Triassic shales are located at Pine Hall, both operated by the Pine Hall Brick and Pipe Company. One plant is manufacturing polychrome face brick and the other, erected this year, is making sewer pipe, flue linings and other hollow goods. The plant of R. W. Hedgecock at Walnut Cove uses a flood plain clay for common brick.

The area over which the Triassic shales outcrop is in the southeast corner of the county and is traversed by the Norfolk & Western Railroad. The shales in this county are of two types, one yellow in color and low in plasticity and dry strength, and the other the typical red of the Triassic in the Deep River area.

These shales are of high grade but care must be taken to avoid strata which are very sandy or are so high in fluxes as to cause blistering.

UNION

The plant of the Seaboard Shale Brick Company is located at Shaleton, near Monroe. This plant manufactures a polychrome face brick from pre-Cambrian shales.

Practically the entire county is underlaid with pre-Cambrian shales which are easily available for future development along the route of the Seaboard Air Line.

WASHINGTON

The plant of the Plymouth Brick Company at Plymouth uses a flood plain clay for the manufacture of common brick.

WAYNE

The largest common brick plant in the State and one of the largest in the South is operated by the Borden Brick & Tile Company near Goldsboro. This plant uses a flood plain clay. H. Weil and Brothers also operate a common brick plant near this city, using a flood plain clay.

Two small outcrops of pre-Cambrian shale occur near the western boundary of the county, the important one being in the Little River valley near the Southern Railroad. This shale is somewhat sandy and non-plastic.

WILKES

The Welborn Brick Company at Wilkesboro and the S. V. Tomlinson plant at North Wilkesboro manufacture common brick from flood plain clays.

Production

During the years 1927 and 1928 there was a decrease in the production of heavy clay products in North Carolina. From 1922 to 1926 there had been a steady increase in production. The slump in 1927 was due largely to the let-up in the building trade. It has been reported that the production in the first part of the year 1929 was far greater than that during the first part of the year 1928. In all probability the production for 1929 will be back to normal.

The table below shows the total value of heavy clay products produced in this State during the past five years.

TOTAL VALUE OF HEAVY CLAY PRODUCTS IN NORTH CAROLINA FROM 1924 TO 1928, INCLUSIVE

Year	Value
1924	$4,000,431.
1925	4,170,445.
1926	4,256,901.
1927	3,862,186.
1928	3,826,493.

COMMON BRICK

There are only a few counties in the State that do not contain clay suitable for the manufacture of common brick. The clays suitable for such brick are both the residual and sedimentary clays. Many of the counties have clays suitable for the manufacture of pressed brick, face brick or decorative brick. A great deal of attention has been paid in the past few years to details in the manufacture of common brick and as a result a better and more homogeneous brick has been put on the market. From year to year in the past five years the increase in production has just about kept pace with the extensive building program put on in the State. Practically all of the new high school buildings have been constructed with brick manufactured in the respective counties.

In 1927, there were 64 plants distributed in 41 counties of the State which produced common brick. These plants produced 249,559,000 brick valued at $2,335,059. The stocks on hand at the end of the year were 28,264,000 brick.

In 1928, there were 52 plants which produced common brick. These plants produced 247,665,000 brick valued at $2,460,446. The stocks on hand at the end of 1928 were 38,422,000 brick.

HIGH GRADE BRICK AND TILE

The high grade brick and tile produced in this State are manufactured from high grade sedimentary clay or from clay shale. The plants producing such materials are located principally in Lee, Stanly, Union, Stokes and Guilford Counties. Two new plants, one for the manufacture of tile and the other for face brick, were under construction in Forsyth and Rockingham Counties respectively. These plants are to use the Triassic shales of the Dan River area of Stokes and Rockingham Counties.

In 1927 there were nine plants producing face brick, one producing hollow brick and two producing tile, in North Carolina. The nine face brick plants produced 43,064,000 face brick valued at $695,500.

In 1928, there were 10 plants which produced face brick. These plants produced 53,333,000 brick valued at $697,189. The stocks on hand at the end of 1928 were 7,267,000 brick.

TOTAL VALUE OF FACE BRICK AND TILE PRODUCTION IN NORTH CAROLINA IN 1927

Material	Quantity	Value
Face Brick	43,064,000	$ 695,500.
Hollow Brick	949,000	13,947.
Building Tile	31,726 tons	199,049.
Other Tile	38,550 tons	599,703.
Total		$1,508,199.

TOTAL VALUE OF FACE BRICK AND TILE PRODUCED IN NORTH CAROLINA IN 1928

Material	Quantity	Value
Face Brick	53,333,000 brick	$697,189.
Hollow Tile	28,602,000 brick	154,753.
Other Tile	62,319 tons	699,408.

NUMBER OF BRICK AND TILE PRODUCED IN NORTH CAROLINA DURING 1927 BY COUNTIES

County	Common Brick	Face Brick	Tile
Alamance	3,900,000		
Beaufort	960,000		
Bertie	2,000,000		
Burke	650,000		
Cabarrus	2,300,000		
Caldwell	1,000,000		
Chatham	16,370,000		15,889 tons
Cleveland	240,000		
Columbus	2,568,000	484,000	895,241 pieces
Craven	4,363,686		
Cumberland	10,568,000		29,000 pieces
Davidson	150,000	8,500,000	
Durham	2,500,000		
Forsyth	1,870,000		
Gaston	14,000,000		
Guilford			41,294 tons
Halifax	10,406,050		
Harnett	6,000,000		
Henderson	14,909,634		
Iredell	13,468,000		
Johnston	6,950,000		
Lee	29,915,770	5,178,000	11,627 pieces
Lenoir	1,395,500		
Montgomery	11,351,335		
Nash	9,415,000		
Pasquotank	1,600,000		

NUMBER OF BRICK AND TILE PRODUCED IN NORTH CAROLINA DURING 1927 BY COUNTIES (CONTINUED)

County	Common Brick	Face Brick	Tile
Pender	300,000		
Pitt	2,000,000		
Randolph	2,740,000		
Rowan	6,750,000		
Robeson	2,000,000		
Rockingham	984,000		
Rutherford	2,277,000		
Sampson	900,000		
Stanly	8,968,000	9,072,000	
Stokes	8,888,000	6,741,000	
Union	2,233,000	8,935,000	
Washington	18,135,500		
Wayne	34,558,140		
Wilkes	1,426,000		
Total	261,010,615	38,910,000	993,051

POTTERY

There has been a steady increase in the development of the pottery industry in North Carolina for the past few years. There is a well developed pottery industry in the State but the production in 1927 was less than that of the previous year. The demand for hand-painted art pottery made in this State has extended far beyond its borders. Many carloads are shipped each year to the large Northern cities, especially New York, Philadelphia and Washington.

There are plenty of clays in this State suitable for making high grade pottery which are the finer alumina sediments underlying the river terraces found in many of the broader valleys, the better clays being found usually near the shore line of the terraces. Such clays are found underlying the terraces along the Catawba River, north of Morganton and Mt. Holly, Burke County; near Blackburn and Catawba, Catawba County; the South Fork of Catawba River, just north of Lincolnton, Lincoln County; the Yadkin River, near Wilkesboro, Wilkes County; Elkin, Surry County; including the old terraces of the Deep River, near Ulah and Whynot, Randolph County; in Buncombe and Henderson Counties along the French Broad River. In the eastern part of the State along the Cape Fear River, near Fayetteville, Cumberland County; the Neuse

River near Goldsboro, Wayne County; and Contentnea River, a tributary of the Neuse, in Wilson County, near Wilson, are similar deposits of clay.

The value of the production of pottery in North Carolina during 1927 was $27,692 or $3,556 less than that of 1926. In 1928 the production increased to $39,550. The number of pottery manufacturers were ten, operating in six counties. Buncombe County leads with five establishments. There was produced red earthenware, stoneware, yellow and Rockingham ware and art pottery.

LIST OF POTTERY PRODUCERS IN NORTH CAROLINA IN 1927 AND 1928

Name of Company or Producer	Address	Plant Location	
		Town	County
Brown Brothers Pottery Company	Arden	Arden	Buncombe
Pisgah Forest Pottery	Brevard Road, Arden	Arden	Buncombe
Omar Khayyam Pottery	Candler	Candler	Buncombe
Reems Creek Pottery Company	Weaverville	Weaverville	Buncombe
William Penland Pottery	Candler	Candler	Buncombe
Hilton Pottery Company	Hickory, Route 1	Hickory	Catawba
Log Cabin Pottery	Guilford College	Guilford College	Guilford
The Jugtown Pottery	Steeds	Backwoods	Moore
North State Pottery Company	Sanford	Sanford	Lee
Kennedy Pottery	Wilkesboro	Wilkesboro	Wilkes

PRODUCTION OF POTTERY IN NORTH CAROLINA FROM 1926 TO 1928, INCLUSIVE

Year	Value
1926	$31,248.
1927	26,692.
1928	39,550.

VALUE OF DIFFERENT TYPES OF POTTERY IN NORTH CAROLINA IN 1928

Pottery	Value
Red Earthenware (Flower pots, etc.)	$14,790.
Stoneware (except chemical)	6,390.
Garden and Art Pottery	18,270.
Total	$39,450.

In 1928, there were eight producers of pottery in North Carolina distributed among six counties of the State, Buncombe leading with three producers. There was produced red earthenware, red and brown white-lined cooking ware, stoneware, yellow and Rockingham ware, garden and art pottery.

CHROMITE

Although there was no chromite ore produced in North Carolina during 1927 and 1928, yet on account of the constant demand for this mineral in the United States, which is supplied almost entirely by imported ores, and on account of the construction of railroads which now pass very close to extensive chromite deposits, this mineral is treated somewhat briefly in this report. The information given below was taken from Economic Paper No. 9 which is now out of print.

Chromite is an iron-black to brownish-black mineral in color, having a sub-metallic luster. Its hardness is 5.5. Its chemical composition is usually represented by the formula $Fe\ Cr_2\ O_4$ where a part of the iron is replaced by magnesia and the chromium by aluminum and ferric iron. It is found in small amounts in a great many places throughout North Carolina as an associated mineral in peridotite formations, where it occurs in grains and crystals and frequently in imbedded masses near the contact of this rock with the gneiss or other county rock. It is usually massive and from fine granular to compact, but occasionally it is found in small, but perfect, octahedral crystals. At a number of localities in the western part of the State it has been found in considerable quantity, and with proper railroad facilities some of these deposits should be capable of being worked profitably and become sources of supply of chromite. One of the more promising localities is in Yancey County at Mine Hill on the Mine Fork of Jack Creek, five miles north of Burnsville, the county-seat, on the Bakersville Road, where a large peridotite (dunite) formation outcrops on both sides of the road. Seams or pockets of chromite ore are abundant in this peridotite varying from 0.5 inch to 3 inches in thickness. Near the summit of the hill, on the east side of the road, about 150 feet above the road and

stream-bed, a deposit of chromite has been opened from which 25 tons of ore were taken, a large part of which still remains on the dumps. A pit nine feet deep was sunk on the deposit; but this has been filled with water since the work ceased, so that no estimate can be made on the extent of the deposit. Mr. Garrett Ray, of Burnsville, N. C., the owner, reports that the chromite widened to between two and three feet at the bottom of the pit. There are other promising seams or veins, which appear to indicate the existence of a deposit of chromite ore near the contact of the peridotite and gneiss.

On the west side of the road the peridotite formation rises in another hill, and here there are numerous small seams and pockets of chromite. On the extreme western slope of the formation a trench has been cut 100 feet or more into the hill, in which are exposed many small pockets of chromite. The work done in this trench is of a prehistoric character and whether the object of the exploration was chromite or not has never been explained.

With the exception of the pit sunk near the summit of Mine Hill, from which a few tons of ore were shipped, no mining has been done here and very little prospecting has been undertaken to determine the exact extent of the chromite deposits. The distance from the railroad has greatly discouraged systematic prospecting in this region.

An analysis of a selected specimen of the chromite (Baskerville, analyst) gave the following results:

ANALYSIS OF SELECTED SPECIMEN OF CHROMITE FROM MINE HILL, FIVE MILES NORTH OF BURNSVILLE, YANCEY COUNTY

	Per Cent.		Per Cent.
Cr_2O_3	58.00	MgO	8.26
Al_2O_3	15.52	SiO_2	3.20
FeO	14.45	CaO	.70

Although this analysis represents a selected sample of the chromite, yet from the character of the material it is not unreasonable to expect an ore that, by hand-picking and cobbing, will assay in the neighborhood of 52 per cent of chromic oxide, with a low percentage of silica.

About nine miles west of Burnsville, near Price Creek, there is a narrow bed of peridotite on the land of Mr. W. A. Robertson, a quarter of a mile from Price Creek postoffice. A pocket of chromite discovered here yielded nearly seven tons of ore. This exhausted the pocket, and since then no prospecting has been done in this vicinity.

An analysis of a selected sample of this ore (Baskerville, analyst) gave the following results:

ANALYSIS OF SELECTED SAMPLE OF CHROMITE FROM PRICE CREEK, NINE MILES WEST OF BURNSVILLE, YANCEY COUNTY

	Per Cent.		Per Cent.
Cr_2O_3	59.20	MgO	4.42
Al_2O_3	7.15	SiO_2	3.20
FeO	25.02	MnO	.92

In Jackson County, in the vicinity of Webster, there is a large peridotite (dunite) formation extending for about half a mile north of the town to a mile and a quarter south. The widest part of the area, about half a mile, is at Webster, the town being partly built on a dunite hill. The Tuckasege River cuts through this formation about half a mile below the town. Considerable prospecting has been carried on in this region, and numerous veins and pockets of chromite of varying extent have been discovered.

The only deposit of any note found on the north or Webster side of the river is on the east side of the Tuckaseege Road, about 200 yards from the main street of the town, on the land of Daniel Schneider. A pocket of chromite was uncovered here which yielded a number of tons of chromite, most of which was shipped. At a depth of nearly nine feet the pocket pinched out, leaving but a small seam of chromite in sight. Many small seams and pockets of chromite are to be seen, but no other work has been undertaken for chromite on this side of the river.

On the south side of the river, following closely the contact of the dunite with the gneiss, a line of prospect pits have been dug which show the presence of a considerable amount of chromite. The prospecting has been done on the land of

Joseph Hooker, Lawrence Buress, Alf Wilson, James Ashe and Daniel Fullbright, all of Webster, N. C. The most promising deposits are one on the land of James Ashe, where a cut 25 feet long, 6 to 8 feet wide and 8 to 10 feet deep was sunk on a vein of chromite 12 to 18 inches thick, which at the bottom of the cut is 12 inches thick; and another on the land of Daniel Fullbright, where a seam nearly 12 inches thick is exposed in the branch. The nearest shipping point is Sylva, on the Southern Railway, three miles north of Webster.

Chromite has been found at a number of places in the masses of peridotite within two or three miles southwest of Balsam Gap, Jackson County. The most promising outlook for a large deposit is on Dark Ridge Creek, about 525 feet south of the Dark Ridge trestle of the Murphy Branch of the Southern Railway. On the east side of the creek a cut 18 feet deep and 10 feet wide was made on a pocket of chromite, from the bottom of which two seams of chromite six and eight inches thick, respectively, extended. Fifteen tons of ore were taken out of the main pocket. About 200 yards farther south, on the opposite side of the creek, a shallow pit was sunk which encountered considerable chromite. Both these openings were near the contact of the peridotite and gneiss. Between these and in their near vicinity there is a large quantity of float ore. These facts point to this locality as one worthy of further development, with an expectation of finding a large quantity of ore. Its proximity to the railroad is also a great advantage. Analyses show the ore to carry about 49 per cent of $Cr_2 O_3$. The property is owned by the Highland Forest Company of Waynesville, N. C.

No large deposits of chromite have yet been found in North Carolina, but the work done shows that extensive deposits may exist in the State, those described above being the most promising ones known.

The standard chrome ore contains 50 per cent of $Cr_2 O_3$, and the value of the ore increases with each unit over this. Ores as low as 45 per cent of $Cr_2 O_3$ find a ready market, if they are low in silica. The North Carolina ores are of high grade and are usually low in silica.

The largest use of chromite is in the manufacture of ferro-chromium alloys and the metal chromium, which is used in the manufacture of chrome steel. This in turn is used in the manufacture of armor-plate used in combination with nickel. The manufacture of the ferro-chromium alloys can be accomplished in the electric furnace, crucible furnace, or blast furnace, but at the present time it is made most extensively in the electric furnace. Formerly, however, before the converting of our water-powers into electric power, the principal method of making ferro-chrome was in blast furnaces. By this process, however, only a low-grade ferro-chrome alloy could be obtained, the chromium content being from 30 to 40 per cent. With, however, the introduction of the electric furnace for the manufacture of these alloys, the chromium content has been increased to 60 per cent and upwards, and at the present time the alloys that seem to be in the greatest demand are those containing from 60 per cent or more chromium. The main objection to the use of crucible furnaces is that only small quantities of the ferro-chrome alloy can be prepared at one time, but the chromium content is very high. Ferro-chrome alloys are now being prepared in a large quantity by means of the electric furnace in the United States, in France and Germany. Where formerly these ferro-alloys were apt to contain a rather high percentage of carbon, the processes have now been so improved and regulated that ferro-chrome alloys can now be made in the electric furnace that contain but a fraction of a per cent of carbon and the product of the furnace can now be made approximately uniform.

COAL

The coal fields of North Carolina are confined to the Deep River section of the Triassic Basin in Lee and Chatham Counties. The field does not seem to be capable of being developed into a very large producing property or at least that has been the case up to the present time. However, it seems that a maximum production of 500 to 1,000 tons of coal per day can be reached with proper equipment and experienced labor.

During the floods of 1928, the Cumnock Mine was flooded with water but the company began unwatering as soon as the

Deep River subsided. The Carolina Mine just across the river from the Cumnock Mine was not affected by the high water.

Considerable research has been made recently relative to the utilization of the black band and shales below and above the coal as a fertilizer filler. Below is given the report prepared by Andrew Murphey and Dr. F. C. Vilbrandt of the University of North Carolina:

FERTILIZER VALUE OF SOME NORTH CAROLINA SHALES

ANDREW MURPHY AND DR. F. C. VILBRANDT
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INTRODUCTION

The rank that North Carolina has taken in the list of agricultural States has been obtained by the judicious use of fertilizers. The annual fertilizer bill of the State amounts to $50,000,000, exclusive of fish scrap, only 16% of this being supplied by fertilizer plants within its borders. The truck raising of the coastal plains, the tobacco and cotton raising in the cotton and tobacco belts and other general crops require specific fertilizers to insure fair yields and sound crops. This commodity has been recognized as essential for the welfare of the agriculturists and also to the urban population since much of the State's wealth depends upon successful crops within its borders. Use of fertilizer is, therefore, deemed necessary to enable the State to keep step with its aims of progress. The banks and the fertilizer companies have for a long time lent money or extended credit to the poorer farmers so that they might purchase fertilizer material and produce crops which in turn add to the wealth of the State. The agricultural schools and the Department of Agriculture have for a long time pointed the way toward the best use of plant foods, the use of the best plant foods for specific purposes, and to protect the farmer in his purchases. Continued use of chemical fertilizers is necessary if the State expects to maintain its present rank as fourth agricultural State in the Union.

The value of animal fertilizer used in the State cannot be ascertained, but it is believed to be rather small. No matter what the value of such material may be, the farmer has and

will depend upon the chemical fertilizers for his plant foods. The State's annual bill of $50,000,000 is quite a burden upon its agriculture, especially when but 16% of that amount remains in the State. The three main plant food elements are nitrogen, phosphorous and potassium available to the plants as compounds. The nitrogen compounds used in fertilizer are quite varied, as are the sources of nitrogen compounds, but nitrates from Chile, ammonium sulphate from the coke by-products and presently nitrogen products produced synthetically are the main sources for this portion of the plant food. Phosphorus is used almost solely as the super-phosphate obtained by treating phosphate rock with sulphuric acid. Potassium compounds are obtained from the natural potash deposits in France and Germany with a little from western potash lakes.

At present time the State does not produce any nitrogen products but its hydro-electric power developments may lead to the production of synthetic fertilizers from the air. Although there are over 25 fertilizer plants in the State converting rock phosphate into super-phosphate by treating it with sulphuric acid, neither the sulphur for the manufacture of sulphuric acid nor the rock phosphate which the acid re-acts upon, come from within the State's borders. Potash supplies are also entirely foreign to the State. Some mixed fertilizers are made in the State in the form of fish scrap. In general the State depends upon minerals and industries outside of its borders to aid it in maintaining its fourth rank in the list of agricultural States. The possibility of obtaining mineral deposits in the State that will shift some of the money into the State that is at present being sent out seems remote, yet should be always before us and any kind of material that can be used in and as fertilizer should receive some serious consideration.

The entire mineral wealth of the State amounts to over twelve and a half million dollars but less than 4% of this could be used as a fertilizer aid. This 4%, constituting limestone products, however, is used essentially for building purposes. A very common commodity, ordinary red sand, is one mineral found in the State that is used in the local fertilizers. However, with 86% of the mixed fertilizers shipped into the State,

supplying this need would be a valuable addition to the sum of the State's wealth. In general the material used as "filler" is a local non-fertilizer sandy soil. If a mineral product were available that contained one or more of the elements of fertilizer, the farmer would obtain something for his money beside sand.

Studies of some North Carolina shales have revealed that the State does have a mineral that has some possibilities as an aid in meeting its fertilizer bill. The shales referred to are found in the Dan and Deep River valleys. The extent of the shale deposits in the Dan River valley are not well known and, with the exception of the chemical analysis, little comment can be made upon those deposits. The Deep River valley deposits are much more extensive and are quite well known.

THE DAN RIVER VALLEY SHALES

The shales of the Dan River valley that were studied were of the non-oil bearing variety although their outward appearance would seem to indicate the presence of oil. The deposits seem to be extensive but at present this geological data has not been obtained. The use of these shales would depend upon the cost of mining the shale. It does not seem to be practical to utilize these deposits except for local consumption from outcroppings. The shales examined in this valley gave the following results:

TABLE 1

DAN RIVER VALLEY SHALES

Sample Number	Location of Deposit	Nitrogen		Phosphorus	
		as NH_3 %	as $(NH_4)_2SO_4$ %	as P_2O_5 %	as $Ca_3(PO_4)_2$ %
1	Near Walnut Cove	0.55	2.17	0.09	0.20
2	Near Germantown	0.30	1.17	1.02	2.23
3	On Route No. 77, N. C.	0.63	2.48	0.81	1.77
4	Pine Hill Brick Yards	1.00	3.90	1.12	2.45

No tests have been made by farmers in that region with this material and little more can be said than this, that based on Deep River valley shale results, this material could be ground and substituted for filler in fertilizers in that region.

DEEP RIVER VALLEY SHALES

In the Deep River valley, the shales constitute an economic problem to the coal operators. Almost the largest item of cost of coal mining is transportation of coal to the surface. The large amount of shale and slate that must be removed adds to the cost and as long as this has no value it must be handled as little as possible. As much as possible is left in the stopes; that which is brought to the surface must be disposed of in heap dumps, since no ravines or cuts are available for dumping. Removal of large quantities from underground would facilitate mining operations but such procedure with a valueless material and one which would introduce a serious disposal problem on the surface is economically prohibitive.

Farmers in the vicinity have hauled away large quantities of the shales from the dump heaps and scattered it upon soils both in corn and cotton culture. Portions of the fields not treated gave inferior yields and crops. The use of this material by these men led to the investigation of the shales as fertilizer aids.

The extent of the deposits in that region are fairly well known, many borings having been made by various companies interested in the mineral rights in that region. Since the field shows but little variation in the thickness of the various strata of rock and coal, the accompanying log table (Table 2) from a diamond drill hole located on the banks of the Deep River, gives a representative analysis of the locations and thickness of the various formations in the field. Formations 26, 27 and 28 mark the present operations for the recovery of coal from formation 26. The narrowness of the seam makes it necessary to work under low head room. Number 28 is too poor a grade of coal to mine for steam coal but if Formations 27 and 29 could be utilized, the effective height of the chambers could be increased to eight feet. Utilizing Formations 25 and 30 in addition would add two feet two inches more to the head room. The coal in Formation 35 has been found to be a very good coal lying thirteen and one-half feet below the upper workings. The thickness of the lower seam is too small to work by itself and the removal of Formations 34 and 36 would be necessary

to make operations possible. The utilization of the above mentioned formations is, therefore, of vital concern to the operators and would solve many of their present problems. On the other hand the utilization of this material as a fertilizer ingredient would also increase the mineral and agricultural wealth of the State.

TABLE 2

RECORD OF DIAMOND DRILL HOLE

Formation Number	From		To		Materials
	Feet	Inches	Feet	Inches	
1	0		7		Sand
2	7		14		Clay
3	14		30		Sand
4	30		32		Red Shale
5	32		40		Gray Shale
6	40		60		Red Shale
7	60		86		Gray Shale
8	86		91		Black Slate
9	91		96		Gray Slate
10	96		173		Hard Gray Sandstone (Dark)
11	173		178		Gray Shale
12	178		186		Black Slate
13	186		238		Gray Slate
14	238		244		Black Slate
15	244		268		Gray Slate
16	268		275		Black Shale
17	275		297		Gray Shale
18	297		330		Black Slate
19	330		355		Gray Slate
20	355		387		Black Shale (Oil-bearing)
21	387		564		Black Slate
22	564		564	4	Hard Gray Sandstone
23	564	4	602	4	Black Slate and Shale (Oil-bearing)
24	602	4	604	3	Gray Sandstone
25	604	3	604	5	Black Slate
26	604	5	608	3	Coal (High-Grade)
27	608	3	609	9	Black Band (Oil-bearing)
28	609	9	611	7	Coal (Low-Grade)
29	611	7	612	6	Black Band (Oil-bearing)
30	612	6	613	6	Black Slate
31	613	6	615		Fire Clay
32	615		627		Slate
33	627		643		Fire Clay
34	642		645		Black Band (Oil-bearing)
35	645		647	10	Coal (Fair)
36	647	10	649		Black Band (Oil-bearing)
37	649		650		Sandstone

The shales studied in this survey were obtained from the Cumnock Mine and the dump heaps of both the Carolina Coal Company Mines at Coal Glen and at Cumnock. The nitrogens were determined by the Kjedahl method and the phosphorous

by the magnesium ammonium phosphate gravimetric method. In both cases the results represent total constituents. Table 3 gives a summary of the results obtained.

TABLE 3

SHALES OF THE DEEP RIVER VALLEY

Sample Number	Formation Number	Nitrogen			Phosphorus		
		As NH_3 %	As $(NH_4)_2 SO_4$ %	As $(NH_4)_4 SO_4$ Pounds per ton shale	As P_2O_5 %	As $Ca_3(PO_4)_2$ %	As $Ca_3(PO_4)_2$ Pounds per ton shale
1	16	0.41	1.59	31.98	0.79	1.73	34.60
2	18	0.48	1.87	37.4	0.61	1.36	27.20
3	20	0.77	3.31	66.2	0.58	1.27	25.40
4	21	0.48	1.87	37.4	0.26	0.56	11.20
5	23	0.94	3.64	72.8	0.96	2.04	40.80
6	25	0.73	3.05	61.0	0.59	1.30	26.00
7	27	0.56	2.19	43.8	6.80	14.87	297.40
8	29	0.42	1.64	32.8	1.86	4.07	81.40
9	30	0.65	2.53	50.6	3.35	7.13	142.60
10	34	0.60	2.34	46.8	7.20	15.73	314.60
11	36	0.60	2.34	46.8	3.10	6.77	135.40

The shales in the Deep River valley divide themselves into three classes when its utilization is to be considered. First, those deposits that are somewhat inaccessible and whose fertilizer value and the extent of the deposit too small to consider; second, those deposits that are not economically connected up with coal mining operations and which would have to be mined by themselves; third, those deposits that coal mining operations enable close contact and the removal of which would aid coal mining in this region. Formations 16 and 18 belong to the first group, representing a total of 46 feet thickness. Surface outcroppings of these two formations may be found workable. Formations 20, 21 and 23 represent the second class, totaling 248 feet of deposit. To the third group must be included Formations 25, 27, 29 and 30 of the upper coal seam and 34 and 36 of the lower coal seam. The third group totals only 8 feet 10 inches. Table 4 is a sumary of the estimates of the extent of the deposits and available material in the field.

TABLE 4

Sample Number	Formation Number	Thickness of Formation		Estimated Total Tonnage in Field (*given in Million Tons*)	Estimated Total Tonnage of $(NH_4)_2SO_4$ (*Million Tons*)	Estimated Total Tonnage of $Ca_3(PO_4)_2$ (*Million Tons*)
		Feet	Inches			
1	16	13		162	2.5	2.8
2	18	33		413	7.7	5.6
3	20	33		413	13.6	5.2
4	21	177		2,213	41.4	5.7
5	23	38		473	17.7	4.5
6	25	1	2	14	0.4	0.2
7	27	1	6	18	0.4	2.7
8	29		11	11	0.2	0.4
9	30	1		12	0.3	0.8
10	34	3		37	0.9	5.8
11	36	1	2	14	0.3	0.9

Formations 16 and 18 need not be considered at present as available; Formations 20, 21 and 23 constitute a recovery of reserve of over three billion tons of material of which probably no more than 10% would be available may be considered as a future reserve except where the formations outcrop. Of the third class, or Formations 25, 27, 29, 30, 34 and 36, about 50% or 53 million tons of material which at present is not only considered a waste but the utilization of which would solve some financial and engineering problems of coal mining in this region.

The utilization of this shale for filler in fertilizers seems to solve several economic problems for the State of North Carolina.

Several of the above shales have been investigated* and found to be oil-bearing. Formations 16, 20, 23, 27, 29, 34 and 36 were all oil-bearing but only 16, 20, and 23 were sufficiently rich in oils to be of value for such purposes. These formations belong to the class of shales in this region that would have to be mined for the shales themselves but if shale oil were retorted from this class, the spent shales would be of value as a fertilizer aid and as a fertilizer aid would also be of economic aid in retorting the shale since the problem of elimination of spent shale would be solved.

**Oil-Bearing Shales of Deep River Valley,* F. C. Vilbrandt, Economic Paper No. 59, Department of Conservation and Development, North Carolina.

COAL PRODUCTION IN NORTH CAROLINA
FROM 1923 TO 1928, INCLUSIVE

Year	Quantity (long tons)	Year	Quantity (long tons)
1923	36,019	1926	59,936
1924	57,094	1927	53,377
1925	65,153	1928	60,860

As shown by the above table, the production in 1927 was less than in 1926. In the early part of 1928 prisoners from the State Prison at Raleigh were sent to the Carolina Mine. Something over 100 prisoners were at work in the mine at one time. A modern prison camp with all sanitary conveniences was built at the mine. The prisoners were taken from the mine about the middle of the year.

PRODUCERS OF COAL IN NORTH CAROLINA
IN 1927

Name of company	Address	Mine Location	
		Town	County
Carolina Coal Company	Sanford	Cumnock (near)	Chatham
Erskine Ramsey Coal Company	Cumnock	Cumnock	Lee

KYANITE (CYANITE)

Since kyanite is one of the most widely discussed minerals, especially in the refractory trade, it is fitting that something be said relative to its occurrence, distribution and possible uses.

Kyanite usually occurs in long-bladed crystals or in coarsely-bladed columnar masses. The color varies from white to blue, sometimes the center of the blade is blue with white margins; rarely green, gray or black. It is transparent to translucent with a vitreous to pearly luster. The hardness varies in the different directions from 5 to 7 in the scale of hardness. The specific gravity varies from 3.56 to 3.67. The chemical composition, Al_2 SiO_5, and other chemical and blowpipe properties are similar to those of andalusite and sillimanite.

The mineral kyanite is characteristically developed in regions subject to intense regional metamorphism. The greatest

occurrence in this State is in the gneisses and mica schists of pre-Cambrian age. It is often associated with mica, garnet, staurolite, quartz and corundum. However, in certain localities, it occurs in lens-shaped masses in the form which is known locally as the "massive" variety. This massive variety is sometimes practically pure kyanite, running as high as 90 or 95 per cent.

Many of the uses are questionable but there is a possible use in a great many different ceramic bodies, especially in the refractory materials. Experiments and tests have been carried on with kyanite to determine its value in the following materials; spark plugs, refractory brick, porcelain ware, both the china and electrical; sagger clays; in glass manufacture to add toughness; and is especially suitable for chemical ware. It is more or less in an advanced experimental stage at the present time.

Kyanite has been found in many localities in this State, occurring in lens-shaped masses of high grade material and in schists. From a commercial standpoint, the schists offer by far the greater possibilities.

Kyanite is known to occur in large quantities in a schist in Yancey County on the north end of the Black Mountain Range. In this particular locality it makes up from 10 to 40 per cent of the rock mass. The accessory minerals are chiefly quartz, mica and garnet with smaller amounts of tourmaline, staurolite and corundum. The property of J. A. Pollard, Burnsville, N. C., offers great possibilities. A process of concentration has been perfected which guarantees 98% pure kyanite, the remaining 2% being quartz and white mica. It has been proven, however, that these materials are not exactly detrimental to refractory bodies since both take a comparatively high temperature and also act as a bonding material.

Other occurrences are on the property of Judge C. B. Hyatt, J. L. Hyatt and J. F. Shinn just to the south of Micaville; on the property of I. V. Moffatt on Cattail Mountain; near Black Mountain on the properties of Dr. Clifford Porter, Mr. McQueen, Mrs. W. C. Wall and J. O. Burgin. The material near

Black Mountain is more the "massive" variety rather than the schist. It also occurs in Clay County on the property of N. N. Rogers; in Iredell County on property of R. L. Morrison; in Haywood County on properties of E. K. Parton and G. C. Plott; also in many sections of Cherokee, Graham, Caldwell, Jackson, Mitchell, Avery and Wilkes Counties. There is probably as much kyanite in North Carolina as in any other State in the Union.

FELDSPAR

Feldspar is the name assigned to a group of minerals consisting of several species, all silicates of alumina, with one or more of the bases—potash, soda and lime. These species are divided into two groups, the potash feldspars and the lime-soda feldspars. The former group is by far the more abundant in North Carolina. Orthoclase and microcline whose composition is expressed by the formula $K\ Al\ Si_3\ O_8$, are the chief representatives of the first group while albite, with a formula $Na\ Al\ Si_3\ O_8$, is the most important of the second or plagioclase group.

Feldspar is used chiefly as a flux in the manufacture of pottery, electrical porcelain, and some enameled wares. For these materials the spar must be very low in iron and not over 5% or 10% free quartz. It is also used as a flux or binder in emery or carborundum wheels, and to some extent in the manufacture of glass. For the last purpose it can carry 25% of free quartz. Feldspar possesses advantages over quartz in scouring soap because it is softer and less liable to scratch. The high grade selected feldspar is used in the manufacture of artificial teeth. It has been suggested that feldspar can be used as a fertilizer because of its high potash content but no commercial practicable means of extraction has as yet been found.

The feldspar industry in North Carolina is now one of the most important mineral industries in the State. The area, including three counties, Avery, Mitchell and Yancey, in the western part of the State, is now the most important feldspar

producing center in the world. Over 60% of the total production in the United States comes from this locality.

The most important factors which have caused the production to increase so rapidly since the first carload was shipped in 1911 are the large, accessible and comparatively uniform deposits; good transportation facilities in the form of railroads and paved highways; abundance of cheap, native white labor; and the favorable climate which permits mining during the entire year. These four factors have caused the center of production to move, within the past 10 years, from the North Atlantic States to North Carolina.

OCCURRENCE AND DISTRIBUTION

Feldspar occurs in pegmatite dikes. These dikes are known in more than 20 counties in the State confined principally to the mountain district. The pegmatite belt is almost 100 miles wide and extends in a northeast-southwest direction paralleling the Blue Ridge Mountains.

The main feldspar belt may be divided into three smaller belts as follows: The Cowee-Black Mountain belt, the Blue Ridge belt and the Piedmont belt. The Cowee-Black Mountain belt which lies to the west of the Blue Ridge Mountains includes parts of Macon, Jackson, Transylvania, Haywood, Buncombe, Yancey, Mitchell and Avery Counties, has produced all of the feldspar mined in this State. The chief producing district, of which Spruce Pine is the center, is confined to the last three named counties. This district is about 40 miles long and 14 miles wide and is the most promising district of the South.

PEGMATITES

Pegmatites are coarse grained granites composed chiefly of feldspar, quartz and mica. However, a great many other minerals have been found associated with them, some of which have been of commercial importance. Minerals other than the feldspars, quartz, and muscovite mica which have been found rather frequently associated with the pegmatites are Beryl (as golden, blue, emerald, and aquamarine), Biotite, Columbite,

Galena, Garnet (several varieties), Hematite, Kyanite, Magnetite, Pyrite, Tourmaline and Uraninite or Pitchblende.

The question of the origin of pegmatites has been discussed for many years but no definite conclusions have been drawn. It is generally concluded, however, that they represent the residual portion of granite magmas but in just what condition the materials were during the time of injection is not definitely known. Some conclude that they were in a more or less aqueous condition and came up under little pressure while others argue that they were more viscous and came up under considerable pressure. There are arguments for both sides. Usually the dikes run more or less parallel with the schistosity of the enclosing rocks but sometimes they cut these rocks at right angles. Where they follow more or less the schistosity the wall rock is little effected, which would indicate little pressure, while on the other hand where they cut the enclosing rocks at right angles the wall rock is folded into a series of fan folds of 15 or 20 feet from the contact. This intense folding would indicate considerable pressure.

Another question which has never been settled is the cause of the large crystals in pegmatites. Generally speaking slow cooling of a magma gives large crystals and fast cooling small crystals. This, however, is not the case with the pegmatites because some of the smallest dikes contain the largest crystals, especially mica crystals. If fast cooling of the pegmatites caused small crystals, the smaller the dike the more rapid the cooling and, consequently, the smaller the crystals. This is not true, as stated above, so another reason must be given. It has been suggested that as long as the magma was in motion crystals grew because the moving solutions provided the necessary mineral matter for the crystals. Then just as soon as the magma froze or ceased moving the crystals stopped growing. This would then explain the cause of the large crystals in the small dikes.

The pegmatite dikes assume numerous forms and shapes. They may parallel the planes of schistosity of the enclosing rocks or may cut them at any angle. The width of the dike varies from stringers less than an inch in width to several

yards. The length may be only a few feet or several hundred yards. The depth varies as much as the width. Some of the dikes in this State have been worked to a depth of 150 or 200 feet. One dike, however, has been worked to a depth of 250 feet. Sometimes they give out at a very shallow depth. The larger dikes often have horses of slate imbedded in them some of which reach enormous sizes and are too expensive to move.

MINING

All of the feldspar produced in this State is mined by the open pit method except that produced at one underground mine. This mine does not operate at full capacity due to the high cost of mining. The overburden on the dikes is moved by hand, drag scrape, or hydraulic methods, depending entirely on local conditions. Since most of the mines are on the hillsides the "bench" method is used in order to give more working face in the narrow dikes. In the larger mines drilling is done by compressed air drills but in the smaller, isolated mines hand drills are employed. Just enough dynamite is used to well loosen the spar. After this is done picks, crow-bars and other similar tools are used to get the spar. The spar is then "hand-cobbed" to free it of impurities, especially quartz and mica. This "hand-cobbing" is one of the most expensive steps in the mining of the spar. On the average only one ton of marketable spar is recovered to every five tons of "ore" mined. The cost of mining then depends on the per cent of marketable spar recovered. In some of the best mines the actual mining has been as low as $1.90 per ton while in others it runs as high as $5.00. The average cost of mining under all conditions is about $3.00 per ton. This does not include the hand-cobbing.

Various methods of transporting the crude spar from the mines to the railroads or grinding plants are employed. When the mines are located on or near the paved roads automobile trucks are used. When the mines are inaccessible for automobile trucks the means of transportation are aerial cable, narrow gauge tram and caterpillar tractor. The three largest and most productive mines are served by narrow gauge tram roads. Three other large mines are served by aerial cable

with tipple and storage bins at the railroad or highway. The tipple is connected with the mines by a single span cable about 2,200 feet long.

The cost of transporting the spar to the railroad or grinding plants depends of course on the methods employed and the distance. The cost varies from 35 cents to $2.00 per ton with an average of about $1.25.

Two of the modern mills have practically abandoned the "hand-cobbing" process by installing jaw crushers and picking belts. The largest grinding plant in the State has the crusher and picking belt at the plant and all the material taken from the mine is transported to the mill. The mine, the only underground mine of importance operated in the State, is about one mile from the plant on the opposite side of the river. The product of the mine is taken by gasoline tram to a point opposite the plant on the same side of the river as the mine. From here the spar is taken by aerial cable to the storage bin and crusher.

The latest mill completed does not have the picking belt at the plant but the crusher, picking belt, tipple and crude bins are at the mines. A complete description of this mill is given below:

The new feldspar grinding plant of the Feldspar Milling Company, Burnsville, N. C., which began operations about May 15, 1929, was the first electrically operated feldspar mill ever designed. The average production of finished spar is about 100 tons per 24-hour day, all of which is produced under strict laboratory control, an analysis accompanying every shipment. It is marketed under the trade name of "Celospar," a name taken from Mt. Celo from which the spar comes; the Harshaw Chemical Company is the exclusive sales agent for the product.

The Feldspar Milling Company owns in fee 2,000 acres of mountain land on which 10 pegmatite dikes occur. These dikes vary in width from a few feet to 200 feet or more and can be traced by outcrops for a distance of two or three thousand

feet. Several engineers and geologists examined the property and all were very much pleased with the possibilities, among them being Heckenbleikner, consulting engineer, Charlotte, N. C,, who stated that it was the largest and most accessible deposit of feldspar in North Carolina. H. S. Brownfield, mining engineer from Pittsburgh, after a thorough examination, reported "that there are 10 pegmatite dikes varying in width from 10 to 300 feet which run through the entire mountain and contain some of the best spar found in the State." He also stated that there was sufficient spar in sight to supply the mill at full grinding capacity indefinitely. The writer also personally examined the property and is willing to agree that it is one of the largest undeveloped properties in North Carolina.

Up to the present time, all of the prospecting done on the property has been confined to the outcrops of the dikes on the mountainside next to the plant. Eleven pits and mines have been opened, all of which show a good grade of spar. The largest opening, formerly worked by the Clinchfield Products Company, is known as the "Clinch Mine." This mine is an open pit mine from 20 to 30 feet in width, 100 feet deep at the deepest place and follows the dike for 300 feet. One of the views shows the exposure of spar at this mine. The relative size is shown by the man with wheelbarrow in the center foreground. From this mine and the immediate locality the company expects to get enough spar to supply the plant for the first few years. The only spar purchased from mines other than from the company's property is that necessary for blending purposes.

The mining of the spar is done by the usual method, that is, by the open pit-bench method. The drilling is done, at present, by compressed air drills driven by a gasoline engine. The spar, after being blasted down, is hoisted by an electric-driven hoist to the stock pile. Usual hand-cobbing methods of separating the feldspar, mica and flint (quartz) employed at all feldspar mines in this State have been replaced by a crusher and picking belt. A portable 14x22 inch Reliance jaw crusher, electrically driven, with a daily capacity of 150 tons, is used to crush the crude material to the desired size. A portable

type of crusher is used in order that it may be taken from one stock pile to another.

The crude spar, after being crushed, falls on the picking belt, a Hercules "Special," 160 feet on centers, with a capacity of 150 tons per day. Six men are employed at the picking belt to separate the marketable spar and mica from the gangue, which is left on the belt to be carried to the waste dump while the marketable material is thrown by hand into crude storage bins. The tipple is 24x36 feet and has four storage bins, each 12x18x15 feet, with a capacity of 50 tons each. The spar is separated as it goes into the bins into the various grades desired by the trade. The No. 1 pottery spar contains no free silica or quartz, the No. 2 contains as high as 10% free silica, while the No. 3 or glass makers' spar contains as high as 25% free silica.

The grading of the spar at the picking belt may be done by male or female help, but in either case only those who know thoroughly the various grades of spar are employed. Each "picker" has a particular type of spar to take from the belt. In this manner the spar is separated with surprising accuracy to the various grades. The laborers become skilled "pickers" after only a few days of intensive training.

The crude graded spar is transported by a No. 30 Caterpillar tractor and an Athey 4½-ton trailer to the plant one mile away. It is estimated that the transportation of the spar by this method is approximately 35 cents per ton. The spar is loaded into the trailer by gravity from the bins thereby eliminating the old type hand-shovel method. When the spar reaches the plant it is dumped from the trailer into a series of 13 crude storage bins, the different grades going to the respective bins. Since the spar is graded at the tipple no further grading is necessary at the plant. It is said that this method of transporting the spar from the mines to the grinding plant is the cheapest yet employed by any company in the State.

The plant is composed of three parts, the first 99x39 feet, contains the crude storage bins; the second, 62x54 feet, contains the machinery; and the third, 50x65 feet, has the storage bins for the finished spar. In addition to these storage bins,

there is ample storage space for the finished spar that is sacked before shipping.

In addition to the main plant there is a machine shop 20x60 feet fully equipped to make any necessary repairs. There is also an office building separate from the plant as well as a fully equipped laboratory. A full-time chemist, with an assistant, is employed to make analyses of each shipment. The chemist not only makes chemical analyses but physical analyses such as screen tests, fusion tests, etc., as well. This feature is in keeping with the policies of the modern feldspar producers since the present day consumers demand a physical as well as chemical analysis.

When the crude spar reaches the plant it is weighed and stored in the primary bins, 13 in number, 14x18 feet, with a capacity of 60 tons each. These bins give ample storage space for the spar necessary to keep the plant operating for a period of 10 days or more at full capacity. They hold the reserve supplies of material to forestall any shortage due to the closing of the mines because of unfavorable weather and also store the different types of spar for blending purposes.

The crude storage bins are arranged in two parallel rows, seven on one side and six on the other, between which are conveyor belts. The middle bin on the side next to the plant is occupied by the primary crusher. Two Hercules conveyor belts, each 48 feet on centers, carry the crude spar from the bins to the crusher which is below the level of the bin floors. The conveyor belts are also slightly below the bin floors so that the spar may be shoveled on them with little effort. After the spar is loaded on the belts it is not handled again until it is ready for shipment. The process from this point on is entirely mechanical.

The primary crusher is a Universal jaw crusher with a capacity of 10 tons per hour. This size crusher was installed in order to assure crushing capacity for other grinding units which may be added in the future. Two such units of about 50 tons per day each have already been installed with space provided for the third unit, to be added just as soon as demands warrant it.

From the primary crusher the spar, which has been reduced to minus 1 inch, falls on a conveyor belt 23 feet on centers which carries it to the foot of bucket elevator No. 1. This elevator has a capacity of 10 tons per hour and raises the spar 23 feet to an inclined 24-inch by 5-feet, Link-Belt vibrating screen. The fines, minus one-half inch, are chuted to the bottom of bucket elevator No. 2 while the rejects go to the secondary crusher, also Universal jaw crusher of 7-ton per hour capacity. The recrusher spar passes to the same chute serving the trough of the vibrating screen.

Bucket elevator No. 2 has a capacity of 10 tons per hour, is 42 feet on centers and carries the crushed spar to 12 intermediate storage bins. These bins are 10x17x11 feet with a capacity of 50 tons each and are arranged in groups of four each so that further blending may be made if necessary. From these intermediate bins the spar is fed by automatic feeder direct into the Hardinge conical ball mills.

The Hardinge mill for the glass makers' unit is 48 inches by 8 feet, has a capacity of three tons per hour and is driven by a 75-h.p. electric motor. The ground spar goes by Jeffrey bucket elevator 46 feet on centers to two Link Belt 36 inches by 5 feet screens, each of two-ton per hour capacity. Rejects of these screens goes back to the ball mill for regrinding; the fines go to a belt conveyor running to the storage bins. Since there are four grades of glass makers' spar, 12, 20, 40 and 60 mesh, there are four storage bins for this unit. These bins are 10 feet by 17 feet by 11 feet and each holds 50 tons.

The pottery spar unit is also a Hardinge conical ball mill 48 inches by 8 feet with a grinding capacity of 1½ tons per hour and air classifier in closed circuit with the ball mill. This type of mill has been recently adapted to grinding feldspar and at this plant it has proven an entire success, leaving the plant free from dust at all times.

The discharge of the air classifier is carried by a 24-foot (on centers) belt conveyor to the storage bins. For this unit there are four 50-ton bins each 10 feet by 17 feet by 11 feet. The finished product consists of four grades screened to four

sizes: 90, 140, 200 and 225 mesh. Any type of pottery spar, regardless of analysis or mesh, is produced from this unit.

The entire operation employs about 100 men of which 75 are at the mines and the remainder at the picking belt and grinding plant. Taking all things into consideration this company should be able to produce feldspar as cheaply as any in the State.

The main feldspar producing area in North Carolina is the Spruce Pine district which extends from near Swannanoa on the southwest to Newlands on the northeast, a total length of about 40 miles, and from Spruce Pine on the east to Burnsville on the west, a total width of about 14 miles. Spruce Pine near the east central part of this district is the largest feldspar milling and shipping center in the United States.

Approximately 100,000 tons of feldspar are mined annually from this district and shipped from Spruce Pine and neighboring points.

AVERY COUNTY

All along North Toe River, from a point some two miles northwest of Plumtree to one and one-half miles southeast of Plumtree, are important outcrops of feldspar. On the Avery tract and just south of the North Toe River two miles northwest of Plumtree mining has been done for feldspar. From this point to the village of Plumtree numerous small openings are being worked at present along the south side of North Toe River for feldspar. About 1½ miles southeast of Plumtree and immediately along the north side of North Toe River, L. B. Berrett has recently opened a promising deposit. The deposit is high up on the mountain. The feldspar is carried some 2,000 feet by overhead cable to the highway on the south side of the river to a loading bin. Here the spar is taken in trucks and wagons to the mill of the Tennessee Mineral Products Company at Spruce Pine.

Promising deposits of feldspar are also known to occur in the Yellow Mountains of the southwestern part of Avery and the northeastern part of Mitchell Counties.

MITCHELL COUNTY

This county contains several large deposits of feldspar, some of which are being worked on a large scale.

The English Knob mines 2½ miles northeast of Spruce Pine are located in an important feldspar area on English Knob and along the east side of Beaver Creek.

Some 2½ miles north of Penland on the east side of Bear Creek are important feldspar deposits in the Chestnut Flats area. For a distance of one to two miles west of the Chestnut Flats mines are other deposits that have been worked.

Between Spruce Pine and Penland along both sides of North Toe River are important feldspar mines. The Deer Park mines near Penland are one of the most important feldspar deposits of the region. In addition to the Deer Park mines are the Deak, Cook and Smith mines all within a radius of two miles. Some 2½ miles northwest of Spruce Pine is the Hawkins mine now worked out. On the same property to the south are other deposits of promise.

About 5½ miles south of Penland on the west side of Chalk Mountain is the Hoot Owl mine which has been one of the most important producers of feldspar in this region. Other outcrops of feldspar occur nearby.

About three miles southwest of the Hoot Owl is the Crabtree Falls property at Crabtree Falls. This property, now temporarily idle, has been an important producer. Between the Hoot Owl and Crabtree Falls mines are other outcrops of interest.

About one mile south of the Crabtree Falls mines is the McKinney mine. The McKinney mine is located above the falls. This is now one of the most important producing mines in the county.

In Mitchell County, the Erwin Feldspar Corporation operates the English Knob, Hoot Owl, Crabtree Falls and McKinney mines. The Tennessee Mineral Products Company operates the Deer Park, Cook, Deak and Smith mines. The Orford Soap Company operates the Chestnut Flats group.

YANCEY COUNTY

The North State Feldspar Corporation is running a grinding mill near Micaville and operating the Googe Rock and Bee Ridge mines some three miles to the north along South Toe River. J. A. Pollard owns important feldspar deposits along the south side of the Green Mountains south and west of Dobag Creek. This property is about three miles north of Micaville.

The Feldspar Milling Company has built a modern grinding mill at Bowditch three miles south of Micaville. In the mountain a few hundred yards west of Bowditch on the Hyatt property are deposits of feldspar of the first magnitude. There are other deposits less known but of real promise in Yancey County.

OTHER FELDSPAR DEPOSITS

Near Swannanoa in Buncombe County, feldspar has been worked on a small scale. Deposits have been reported near Webster, near Franklin, Macon County, and near Bryson City, Swain County. None of these have been worked.

Production

In 1927 and 1928 there were 20 large producers of feldspar in North Carolina. There were also other producers who operated on a small scale. Mitchell County still leads in total value of production with Yancey second. The total production for the year was 100,756 long tons valued at $612,214 or about 50% of that produced in the United States. In 1928 it increased to 105,560 tons valued at $630,042, or the highest on record. On September 1, 1929, five grinding plants were operating in the State. Two other plants are also under consideration.

There is given in the table below the production of feldspar in North Carolina from 1923 to 1928.

PRODUCTION OF FELDSPAR IN NORTH CAROLINA FROM 1924 TO 1928, INCLUSIVE

Year	Amount in Tons	Value	Average Price per Ton
1924	97,075	$640,403.	$6.60
1925	76,806	496,563	6.47
1926	91,433	602,020.	6.59
1927	100,756	612,214.	6.08
1928	105,560	630,042.	6.00

As shown by the table above, the average price per ton in 1927 was much less than in 1926 but the total value of production was $9,194 more. In 1928 the average price fell to $6.00 but the total value increased $17,828.

PRODUCTION OF FELDSPAR IN NORTH CAROLINA IN 1927 BY COUNTIES

County	Amount in Long Tons	Value
Avery	1,306	$7,121.
Mitchell	82,962	505,643.
Yancey	7,790	51,679.
Undistributed	8,698	47,771.
Total	100,756	612,214.

PRODUCERS OF FELDSPAR IN NORTH CAROLINA IN 1928

Name of Company or Producer	Address	Mine Location	
		Town	County
Clyde Pittman	Cranberry	Bellevue	Avery
Robert Brockwell	Plumtree	Plumtree	Avery
Burleson & Young	Plumtree	Plumtree	Avery
C. W. Burleson	Plumtree	Plumtree	Avery
Barrett Mines	Plumtree	Plumtree	Avery
J. H. Willis	Boonford	Boonford	Mitchell
Erwin Feldspar Company	Trenton, New Jersey	English Knob	Mitchell
J. A. Conley	Penland	Penland	Mitchell
Penland Feldspar & Kaolin Co.	Penland	Penland	Mitchell
J. C. Pitman	Penland	Penland	Mitchell
Tennessee Mineral Products Co.	Penland	Penland	Mitchell
Whitehall Company, Inc.	17 Batter Place, New York	Penland	Mitchell
Carolina Mineral Company	Spruce Pine	Penland	Mitchell
L. W. Presnell	Kona	Kona	Yancey
Carolina Mineral Products Co.	Greenville, S. C.	Micaville	Yancey
G. W. Kates	Micaville	Micaville	Yancey
North State Feldspar Company	Micaville	Micaville	Yancey
H. C. Smith	Burnsville	Burnsville	Yancey

MICA

BY JASPER L. STUCKEY

For years, North Carolina has been the leading producer of mica in the United States. It still leads in the total production of mica but has been surpassed for the past two or three years by New Hampshire in the production of sheet mica. The production of sheet mica has fallen off in recent years while the production of scrap mica has increased.

The mica producing region of North Carolina consists of a belt of country about 100 miles wide lying in the mountain and Piedmont sections of the State and trending with the mountains. This belt may be sub-divided into three smaller belts; the Cowee-Black Mountain belt; the Blue Ridge belt, and the Piedmont belt.

The more important mica producing counties have been in past years (without attempting to rank them) Ashe, Watauga, Avery, Mitchell, Yancey, Buncombe, Haywood, Jackson, Macon, Transylvania, Rutherford, Cleveland and Lincoln, while Gaston, Catawba, Burke, Wilkes, Yadkin, Stokes and Person have produced small amounts.

A recent brief survey of North Carolina indicates that the production at present is coming from Avery, Mitchell, Yancey, Haywood, Jackson and Macon Counties. Minor amounts may also come from other counties as every old mine was not visited.

AVERY COUNTY

Tar Heel Mica Company is producing mica products, using both domestic and imported mica. D. T. Vance has two wet grinding mica mills near Plumtree, both idle. T. B. Vance has one wet grinding mica mill near Plumtree idle. These three mills are on North Toe River and use water power. For about two miles to the north and west of Plumtree along North Toe River, a number of feldspar prospects have recently been opened; not much mica is being produced. Avery County was at one time an important producer of sheet mica.

MITCHELL COUNTY

Only one mica mine operated as such and producing sheet mica was reported in Mitchell County. Mr. James Mabry is operating a mine for sheet mica. This mine is known as the Green Mine and is probably the Gibbs Green Mine.

The Spruce Pine Mica Company is mining mica and producing manufactured mica products. The mica mined by this company comes chiefly from Yancey County. Some is bought from producers around Spruce Pine.

The English Mica Company is operating at Spruce Pine a wet grinding plant for grinding scrap mica. Some of this is bought locally around Spruce Pine and some is shipped from Macon County.

The Asheville Mica Company maintains at Spruce Pine an office for buying mica. This company buys sheet and scrap mica from both Mitchell and Yancey Counties.

Biotite Mica Company: This company operates at Spruce Pine a wet grinding plant in which biotite schist is ground for the rubber trade. A mine is operated about 2½ miles northeast of Spruce Pine where the schist is mined. This mine consists of an open cut about 300 feet long. A depth of 30 feet has been reached in the quarry face. A total width of about 100 feet has been quarried off the hillside where the biotite schist outcrops.

Nassau Producing Corporation: About two miles northeast of Spruce Pine this company operates a dry grinding plant for roofing mica. Muscovite schist is ground. The plant was built to operate a schist quarry nearby but the deposit has been worked out. Schist is mined and hauled in from a radius of five or six miles.

Another important source of mica in Mitchell County is the fine flakes associated with the kaolin deposits. Three companies are now screening, drying and saving the mica from clay washing plants.

The Norman G. Smith Company is operating a clay washing plant about one mile east of Spruce Pine and saving flake mica finer than 20 mesh.

The Harris Clay Company is operating the Spruce Pine Clay mine on the east edge of Spruce Pine. A mica screening and drying plant has been installed and the mica from this clay mine is being saved.

The General Mica Company, Spruce Pine, is operating two drying and screening plants to obtain the fine mica from the Firescald and Penland Clay Mines. Much mica too coarse to go through the screen is being lost. Plants are being built to save and clean all the mica washed from these clay mines. The coarse mica will be ground and saved. All the mica saved from clay washing is used for roofing filler.

In addition to the various types of scrap mica and mica schist saved in Mitchell County considerable mica is obtained from feldspar mining operations. The Tennessee Mineral Products Company obtains considerable sheet and scrap mica from their mines especially the Deer Park Mines. Golding Sons Company and the Erwin Feldspar Corporation operate a number of feldspar mines in Mitchell County especially the English Knob, Hoot Owl, Crabtree Falls and McKinney. All these mines produce more or less mica. These companies operate the Carolina Mineral Company as a division which handles the mica from their mines. The mica is sheeted in Spruce Pine and the scrap is sent to the Richmond Mica Company for grinding.

YANCEY COUNTY

Golding Sons Company operate a feldspar mill and mines in Yancey County. The Googe Rock Mine produces considerable mica which is handled from Spruce Pine.

In Yancey County the Spruce Pine Mica Company operates the Sallie Googe Mine which has been a good producer recently. The Gibbs Mine and the Charles Robertson Mines near Boonford are in operation.

I. V. Moffett and Percy Threadgill of Burnsville are operating a mica mine on Cattail Mountain south of Burnsville.

The Erwin Feldspar Corporation has a wet grinding mica mill on South Toe River near Micaville that is idle and one at Crabtree Falls that is also idle.

BUNCOMBE COUNTY

The Asheville Mica Company is operating a plant at Asheville for producing manufactured mica products. If any mica is being mined in Buncombe County, it was not reported during the recent investigation.

HAYWOOD COUNTY

The Big Ridge Mine six miles southeast of Waynesville is being operated for sheet and scrap mica.

JACKSON COUNTY

Only one mine was reported in operation in Jackson County. Mr. Morris Rubin of Waynesville is said to be operating a mica mine near Webster.

MACON COUNTY

Two companies are operating three old mica mines for scrap in Macon County.

The Southern Mica Company is operating the Iotla Clay Mine and the Boyd Knob or Cowee Mine for scrap mica. Both operations consist of open cuts. The weathered pegmatite is dug down by hand and carried or washed into screens where it is washed and screened to size. The scrap from the Boyd Knob or Cowee Mine is sent to Spruce Pine for grinding. At the Iotla Mine a dry grinding plant is in operation where most of the fine scrap from this mine is dry ground for roofing.

Franklin Mineral Products Company: This company is operating an old mica mine near Wests Mills. Scrap mica is saved and cleaned. A grinding mill is being built on the railroad at Franklin.

RUTHERFORD COUNTY

Until recently a grinding mill was in operation at the old Isinglass Mine in Rutherford County. This has been recently closed.

No other operations have been known for mica in the Piedmont in recent years. However, recently the Catawba Mining Corporation of Newton reported to the Department that it expected to open a mine known as the Johnson Mine located

in Bandy's Township, Catawba County. J. W. Yount is the secretary-treasurer of the corporation.

NEW MICA RECOVERY PROCESS

A new process for the recovery of scrap mica from kaolin clays has proven very successful in North Carolina. Four new plants have been built within the past year and each of them is proving to be an economic success to the owner.

The kaolin or china clay from which the mica is recovered is of the residual type. This clay is formed by the alteration of feldspar in pegmatite dikes or coarse granites. This type, when properly washed and cleaned, is the purest clay known, being almost pure kaolinite. All of the clay in North Carolina suitable for white ware belongs to this type. It is used chiefly in the manufacture of china, semi-porcelain and porcelain, mosaic and other tile, and spark plugs as well as glass melting pots.

The kaolin clay deposits of North Carolina are found associated with the crystalline rocks particularly in the mountain counties. The most important deposits worked at the present time occur in a belt covering parts of Avery, Mitchell, Yancey, Buncombe, Haywood, Jackson and Macon Counties. Over one hundred mines and prospects are known in this belt. There is a total of seven clay washing plants, only four of which have the mica recovery plants in operation along with the clay washing process.

All of the clay deposits contain more or less mica. The mica is both the biotite and muscovite with muscovite predominating. The mica varies in size from the minute flakes, which occur chiefly in the coarse granites, to small punch mica, which occurs in the true pegmatites. All sizes of mica are recovered by some plants while others recover only that which is finer than 20 mesh. Each plant recovers from three to five tons of mica per day.

The mica recovery process as discussed below was worked out by Mr. H. H. Gaines of the Norman G. Smith Clay Company, Spruce Pine, N. C. A great number of experiments and tests

covering a period of several months were carried out before it proved successful on a commercial scale. Even after the equipment was installed certain small changes had to be made. Other changes may be made in the future but at the present time it seems to be very satisfactory.

The old method of hydraulic mining is employed to bring down the mica and clay. From the clay pit, which is at the present about 40 feet deep, the sludge is raised by a bucket elevator 68 feet high to a trough 28 feet above the level of the ground. The trough is so elevated in order to give the necessary 10% grade. The trough conveys the material to the first unit of the plant 680 feet away.

From the trough the sludge is sent through a beater or disintegrator (a sort of log washer), in order to break the mica from the quartz or undecomposed feldspar which was not completely broken up in the trough. This distintegrator is 4 feet square, 10 feet in length with teeth 30 inches long set on 8-inch centers and revolves at 275 revolutions per minute. A link chain classifier carries out all of the quartz and undecomposed feldspar larger than 10 mesh. This coarse material goes to a waste dump.

From the disintegrator the mica is carried by water gravity trough to a Dorr Simplex classifier. The tailings from this machine are minus 10 plus 40 mesh. The product is minus 40 mesh which goes to the large Dorr bowl classifier. The tailings from the Dorr Simplex classifier go to two 60 mesh revolving screens which make 17 revolutions per minute. From these screens the minus 60 mesh material is wasted. The plus 60 mesh is carried by water in a trough to a Deister concentrator table. This table is one of the most important steps in the process as it separates the grit (quartz and undecomposed feldspar) from the mica. Until this table was used, there was no good method of separating the very finest grit from the mica. The table has to be set at a certain definite angle before the best results can be had.

From the Deister table the grit goes to waste heap while the mica goes by gravity water trough to dewatering wheel.

The screen of the dewatering wheel is 10 mesh finer than the finest mica product which goes into it, that is, mica would be 60 mesh or coarser while the screen of the dewatering wheel would be 70 mesh. The mica finer than 60 mesh goes with the clay slip to the large Dorr bowl classifier.

The product from the large Dorr bowl classifier is screened by two revolving 80 mesh screens. The tailings are sent to the waste heap while the plus 80 material goes to a Deister-Overstrom concentrator table. The product minus 80 mesh from the large Dorr bowl classifier goes to a battery of seven revolving 140 mesh screens. From these screens, the product goes to the drier while the waste, principally clay, goes to the settling tanks. The concentrate from the Deister-Overstrom concentrator table goes to the drier also.

This process gives three products by water classification, namely 20 to 80 mesh, 80 to 140 mesh and finer than 140 mesh. These three products are sent to separate storage bins after being dried rescreened to any mesh desired by the trade.

There are two driers, a direct heat drier which at the firing or hot end reaches a temperature of about 1500° F., and a steam rotary drier which reaches a temperature of about 400°F. From the driers the product is conveyed by a monorail system to storage bins. From these storage bins the different products go to a double deck Rotex screen which has a capacity of 15 tons per day. The products usually desired by the trades are 20-60 mesh, 60-80 mesh, 80-140 mesh and minus 140 mesh.

The product from these plants is sold in direct competition with the water-ground mica. Since these plants have been in operation five water-ground mica plants have closed down in the western part of the State. The small water-ground mica plants usually produce only two tons per 24-hour day while the mica recovery plants produce from three to five tons. The product from the clay pits is in every way as good a product as that produced by the water-ground mica plants and can be used in the same trades. The chief use of this mica is in the roofing trade.

The four mica recovery plants now in operation save close to $125,000 worth of scrap mica annually, an amount which up until this year went to the waste heap or into the streams. This amount is calculated on an operating basis of 300 days per year, with each plant recovering an average of 3½ tons per day. The average price of such mica is about $30.00. On this basis during the last 15 years there has been lost several million dollars worth of mica for during that time an average of six clay plants have been operating in this State.

VERMICULITES

Since there is quite a bit of interest in the possible economic use of the vermiculites it is thought advisable to give what information is available concerning them at the present time.

In Volume 1, "Corundum and Peridotites of North Carolina," Pratt and Lewis have described the vermiculites and their occurrences in North Carolina as follows:

"This supplementary group of the micas includes a number of micaceous minerals which are hydrated silicates varying somewhat widely in composition and being in part closely related to the chlorites. They are alteration products of some of the micas and chlorites, and have usually retained the characteristic micaceous cleavage. The laminae are generally soft, pliable and inelastic with a pearly or bronze-like luster. The color varies from white to yellowish and brown. The common characteristics of all the vermiculites is the property of exfoliation; opening out into worm-like threads when heated. Some show this exfoliation to a much greater degree than others.

"The vermiculites are of a more or less indefinite chemical composition and vary widely in their composition according to the original mineral from which they are derived and the degree of the alteration. A chemical analysis is nearly always necessary to identify the different varieties, for as the variety depends on the degree of the alteration, different portions of the same specimen often show two varieties of vermiculite."

Dr. Genth, in a paper in the "American Philosophical Society Journal," Vol. XIII, Page 359, 1873, describes a number of the vermiculites that he identified in North Carolina. The following have been found in North Carolina:

JEFFERISITE OR CULSAGEEITE

This mineral occurs at the Corundum Hill mine in folliated masses of yellowish-brown color and also in greenish, brownish-yellow scales, not over one-eighth of an inch in diameter.

KERRITE

This variety consists of innumerable fine scales of a pale greenish-yellow color and of a pearly luster and was found also at the Corundum Hill mine.

MACONITE

This variety was identified at the Corundum Hill mine by Genth who described it as a dark brown scaly mineral with pearly luster inclining to sub-metallic.

LUCASITE

This, another mineral similar to jefferisite, was identified by Mr. Chatard at the Corundum Hill mine. It is yellowish-brown in color and made up of small laminae not over 2mm. in diameter. The basal cleavage is eminent and the luster sub-metallic to greasy.

WILLCOXITE

This vermiculite occurs in greenish-white scales of a pearly luster, somewhat resembling talc. It has been identified at Shooting Creek and Buck Creek, in Clay County. It has been found surrounding corundum and is probably the result of the alteration of that mineral. It is one of the easier of the vermiculites to identify in the field.

DUDLEYITE

This mineral has been found very sparingly in Clay County at the Buck Creek mine. It has a soft bronze or brownish-yellow color; a pearly luster and is probably the result of the alteration of margarite, whose form it still retains.

ANALYSES OF VERMICULITES

	Jeffersite	Kerrite	Maconite	Lucasite
SiO_2	34.00	38.31	34.22	31.81
Al_2O_3	20.35	11.41	21.53	12.99
Fe_2O_3	4.91	1.93	12.41	5.29
FeO	0.42	0.32	0.32	0.11
NiO	0.57	0.29	0.12	------
MgO	21.71	26.30	14.46	24.83
Li_2O	------	------	Trace	------
Na_2O	------	------	0.51	0.20
K_2O	------	------	5.70	5.76
H_2O	------	------	11.85	6.98
Ignition	18.50	21.22	------	------
	100.47	99.78	101.12	99.75
Specific Gravity	2.2	2.303	2.827	2.3

The chief characteristic of the vermiculites so far identified in North Carolina is that when heated even to a moderate heat they lose considerable water and exfoliate or curl up in worm-like threads which are rather light and fluffy. When the fine fragments, which are more or less needle-like, are heated with a lighted match, the resulting material is a very light, fluffy, ash-like substance. The rapid expansion is due to the escape of the included water. It is said that the vermiculites expand to 18 times their natural size when heated to moderate temperatures.

Mr. C. S. Crouse, head of the Department of Mining and Metallurgical Engineering, University of Kentucky, has done considerable work recently carrying on tests to determine the value of certain vermiculites, principally jefferisite, as a plaster base. He states that "the investigation was undertaken to determine a satisfactory temperature for calcination and also to investigate the possibiliy of mixing the calcined material with the inorganic binders to secure a light-weight, heat-and-sound-insulating plaster." The results of his tests are interesting and will probably prove of economic value when completed. He found that swelling began at 400°F. but calcination was not complete at that temperature. After being left in the furnace at 1750°F. for five minutes calcination was complete. He tried several binders such as cement, a plastic Kentucky clay, magnesium oxychloride, plaster of paris, etc., and found that

the plaster of paris was the best. He also used varying amounts of asbestos in the mix to add strength. The best results were obtained when the following mixture was used; plaster of paris, 30 per cent; calcined vermiculite, 60 per cent; and asbestos, 10 per cent.

Mr. Crouse concludes "that the work done indicates that commercial plasters using calcined vermiculite as a base are worthy of further investigations and test on a larger scale than is possible in the laboratory. On account of the extreme lightness of the calcined vermiculite, and its consequent great bulk compared to its weight, the material will have to be calcined at the point of use, however, rather than at the point of production."

All of the vermiculite tested by Mr. Crouse came from Montana. It is said that the deposit from which the material came is "a dike-like formation 100 feet wide by 1,000 feet long. Its depth is at least 100 feet, but its ultimate limits are unknown." The per cent of vermiculite in the mass is said to be from 30 to 84 with an average of about 50. In 1923 it was planned to work the deposit and sell the expanded or exfoliated material, called Zonolite, as an aggregate in magnesium oxychloride cement products, as a light-weight, fireproof substitute for cork in all types of heat and sound insulation, etc.

Another deposit of vermiculite, variety jefferisite, occurs near Westcliffe, Custer County, Colorado, where it occurs in a mass, varying in width to 30 feet or more and of unknown depth. It is said that this material averages 50 per cent vermiculite. It was planned to work the material, refine the ore and prepare the ore, by roasting, for use as an insulating material for steam pipes, refrigerating equipment, insulating brick, wall board, etc. Two other deposits are known in Colorado.

As far as is known to date the deposits of vermiculite in North Carolina are the only deposits in the eastern United States which offer commercial possibilities. Due to this fact, there is a possible development in this field in the near future, because the freight rates to Eastern markets is decidedly in favor of the North Carolina product. Already two or three

Northern companies are interested in the North Carolina deposits. Several samples have been submitted by the State Geologists to these Northern companies which are pleased with the preliminary tests. Further tests will be made at an early date.

According to Mr. N. N. Rogers, Shooting Creek, Clay County, North Carolina, there are large deposits of the jefferisite variety of vermiculite in that county which are rather large, high grade, and very accessible. In a letter from him of recent date he states "as to the quantity of vermiculite, I have an unlimited tonnage similar to that being mined at Libby, Montana. I have cut the vein at nine places, nearly a mile in length, and at several places 45 feet across."

Other than the large deposits in Clay County, samples of vericulite have been received at the office of the Department of Conservation and Development from Macon and Yancey Counties. Most of the deposits so far located are very accessible and from samples received are very pure. The vein or dike material in Clay County is said to be practically pure, at least pure enough that no milling or concentrating is necessary.

According to information received so far the principal uses of vermiculite are in the manufacture of insulating material for steam pipes, refrigerating equipment, insulating brick, wall board, as an aggregate in magnesium oxychloride cement products and as a light-weight, fire-proof substitute for cork in all types of heat and sound insulation. Since North Carolina also has an abundance of kaolin clay and asbestos deposits near the vermiculite deposits it seems that this State would be a logical location for a plant to manufacture any of the above mentioned materials.

Production

In 1927 and 1928 North Carolina held second place in the United States in the production of mica. Due to foreign competition in those years the production of sheet mica decreased from 700,313 to 402,758 pounds and in value from $150,362 to $80,331 in 1927. In 1928 the production of sheet mica in-

creased to 777,395 pounds valued at $129,706. Most of this production was a by-product from the feldspar mines. Only a few mines are operated for sheet mica. The production of scrap mica decreased from 2,880 to 2,139 tons and in value from $54,048 to $37,238 in 1927. In 1928 the production of scrap increased, however, to 4,419 tons valued at $69,638. Five wet-ground mica plants closed down during the year 1927, which was partly if not entirely due to the new process for the recovery of mica from the kaolin clays. During the same time, however, a modern wet-grinding plant—supposed to be the largest in the United States—was completed at Franklin, N. C. This plant will be supplied by material from a large mica mine operated by the same company and from small mines which are producing mica in that section of the State.

PRODUCTION OF MICA IN NORTH CAROLINA
FROM 1923 TO 1928, INCLUSIVE

Year	Sheet Value	Scrap Value	Total
1924	$108,656.	$59,620.	$168,276.
1925	88,624.	91,574.	180,529.
1926	150,362.	54,048.	204,410.
1927	80,331.	37,258.	117,589.
1928	129,706.	69.638.	198,344.

The production in 1927 as shown by the above table is the lowest on record during the past five years. The prices of mica continue to decrease due to foreign competition. It is reported by mica producers and manufacturers that mica can be imported from India, South Africa and France cheaper than it can be produced at local mines. As a result of this condition a great many of the mica finishing plants use the imported mica even though it is not as good mica as that produced locally. Unless a duty is placed on foreign mica there will be no mines operated for mica in this State during the next few years.

PRODUCTION OF MICA IN NORTH CAROLINA
IN 1927 BY COUNTIES

County	Sheet (Pounds)	Value	Scrap (Tons)	Value	Total Value
Avery	----	$ ----	13	$ 246.	$ 246.
Macon	11,078	1,365.	1,329	22,593.	23,958.
Mitchell	240,788	40,447.	568	10,311.	50,758.
Yancey	150,892	38,519.	229	4,108.	42,627.
Total	402,758	$80,331.	2,139	$37,258.	$117,589.

PRODUCERS OF MICA IN NORTH CAROLINA
IN 1927

Name of Company or Producer	Address	Plant or Mine Location	
		Town	County
E. H. Patrick & Co.	Spruce Pine	Plumtree	Avery
W. W. Wiseman	Newland	Newland	Avery
Franklin Mineral Products Co.	Franklin	West Mills	Macon
Southern Mica Co.	Franklin	Franklin	Macon
J. A. Bartlett	Spruce Pine	Spruce Pine	Mitchell
Carolina Mineral Company	Spruce Pine	Estatoe	Mitchell
Erwin Feldspar Company	Spruce Pine	Spruce Pine	Mitchell
J. C. Pitman & Co.	Penland	Penland	Mitchell
Norman G. Smith Company	Spruce Pine	Spruce Pine	Mitchell
Spruce Pine Mica Company	Spruce Pine	Spruce Pine	Mitchell
Tennessee Mineral Products Co.	Penland	Penland	Mitchell
J. C. Burgin	Newdale	Newdale	Yancey

QUARTZ

Quartz is one of the most abundant of all minerals, and is the chief constituent of a great many rocks, especially acid igneous rocks as granites, etc.; metamorphic rocks, as quartzites and acid schists; and sedimentary rocks, as sandstones. It varies widely in its mode of occurrence and uses.

The form of quartz used commercially in this State is the massive crystalline variety, often known as vein quartz; "flint," a by-product of the feldspar and kaolin clay mines; quartzite, which when ground, is used as sand and in the ceramic trade. There are also some varieties, such as rose or smoky quartz, amethyst, etc., used as gems.

Quartz occurs at a great number of places in this State. The production comes chiefly from the feldspar mines of Mitch-

ell, Avery and Yancey Counties. The quartzite rock of Cherokee County has been quarried at a few localities for use as a flux in copper smelting. This vitreous variety of quartzite occurs in the Cambrian formations and extends over several of the western counties but has been mined only in Cherokee. In this county it is known as the "Tusquitee quartzite" and parallels the Murphy marble. Important deposits of quartz have recently been found in Buncombe and Transylvania Counties.

The vein quartz also occurs in several of the lower Piedmont counties as Anson, Montgomery, Moore and Harnett. At times, it is found in its original position cutting the old "slates" while at others it occurs as pebbles in the Lafayette formation of the Coastal Plain deposits.

The chief uses of quartz are: in pottery manufacture to diminish the shrinkage of the ware in burning; in the manufacture of scouring soaps; paints; wood filler; sandpaper; filters; and tooth powders; as a flux in copper smelting; in the manufacture of silicon and ferrosilicon. A great deal of the chemical ware is made of fused quartz. The massive quartz and quartzite are employed as filters for acid towers. The crystalline variety is also used in the manufacture of lenses.

The production of quartz in 1927 was greater than that of the previous year. That produced in this State was used chiefly in the ceramic trade and came as a by-product from the feldspar mines. It was sold in the crushed, ground and crude forms. The average price of the crushed was about $6.50 per ton; the ground from $25.00 to $30.00 per ton; and the crude from $2.50 to $7.50 per ton.

PRODUCTION OF QUARTZ IN NORTH CAROLINA
FROM 1925 TO 1927

Year	Tons	Value	Average Value per Ton	
			Crude	Ground
1925	----	$21,286.	$3.50	$21.00
1926	2,134	17,457.	4.73	32.00
1927	3,396	19,853.	3.72	30.46

PRODUCERS OF QUARTZ IN NORTH CAROLINA
IN 1927

Name of Company	Address	Mine Location	
		Town	County
Oliver Quartz Company	Charlotte	Mt. Holly	Gaston
Penland Feldspar & Kaolin Company	Penland	Penland	Mitchell
J. C. Pitman	Penland	Penland	Mitchell
Erwin Feldspar Company	Spruce Pine	Spruce Pine	Mitchell
Carolina Mineral Company, Inc.	Spruce Pine	Spruce Pine	Mitchell
Fortner Sparks	Green Mountain	Green Mountain	Mitchell
Tom Laws	Green Mountain	Green Mountain	Mitchell

SAND AND GRAVEL

On account of the great number of requests coming to this Division for information on the sand and gravel deposits of this State it is thought advisable to give a short report on such materials.

The sand and gravel produced in North Carolina consists chiefly of building sand, paving sand, engine sand, gravel for railroad ballast, gravel for road making and a small amount of fine sand for polishing and grinding. Up to the present time no glass sand has been produced although a great many deposits were examined and tests made on samples from Moore County in the vicinity of Aberdeen.

The chief type of sand and gravel produced in this State are for the construction of buildings and roads. These materials are used for making plaster, mortar, concrete, and concrete products as brick culvert pipe, blocks, etc. Sand and gravel suitable for all of the above products are found in the State. Before being used as such all of the sand and gravel must be washed and screened.

Sand, for all types of products, is composed chiefly of the mineral quartz, $Si\ O_2$, and when pure it is colorless or white with a glassy appearance. In the scale of hardness it is about 7, hard enough to scratch steel. The quality of a sand depends on the shape and size of the grains and on the amount of impurities. The chief impurities in a sand depend entirely on the type of rocks from which it comes. Since the rocks of

this State are chiefly the crystalline variety, composed of quartz, feldspar, muscovite mica and the ferro-magnesian minerals as biotite mica, hornblende, augite, etc., the chief impurities would be feldspar, mica, hornblende and clay which is the result of the weathering of these minerals, as well as organic material. Most of the clay, mica, and organic matter is eliminated when the material is sent through the washing and screening process.

The gravels of the lower Piedmont and Coastal Plain deposits are composed of the more or less rounded quartz pebbles which originated in the quartz veins that cut the Proterozoic rocks which lie to the west of the fall line. The round form is due to the wearing caused by stream and wave action before and during deposition.

The gravels of the upper Piedmont and Mountain sections of the State are composed of quartz pebbles and fragments of the older crystalline rocks. These gravels are also more or less rounded and vary in size from coarse sand to large-sized boulders. Crushing as well as screening has to be applied to a great deal of these gravels before being suitable for the trade.

The information included in the report below is taken from unpublished reports by Drs. J. H. Pratt and J. L. Stuckey, former State Geologists, and from the personal notes of the present State Geologist. The information is listed by counties alphabetically.

SAND AND GRAVEL DEPOSITS IN NORTH CAROLINA

North Carolina has a fair amount of sand and gravel in the water-formed deposits. These deposits are fluviatal (streams), fluviomarine (streams and sea), marine (sea), and lacustrine (lake) in origin. In the Mountain and upper Piedmont regious deposits are limited entirely to the bottom or flood plain areas along the streams. In the lower Piedmont and Coastal Plain deposits they are rather widespread and follow more or less the old shore line. The best deposits are in the areas known as "beach terraces."

The most important sand and gravel deposits cross the State in a northeast-southwest direction and lie just east of the fall line. The richest deposits occur where the larger rivers enter the ocean. Geologically these deposits belong to the Lafayette formations of Pliocene age. This formation has been rather well marked out across parts of Anson, Richmond, Moore, Harnett, Johnston, Nash, Halifax and Northampton counties. The important deposits are near the Pee Dee River in Anson County; well distributed over Moore County; along the Cape Fear River near Lillington in Harnett County; and in Halifax and Northampton Counties along Roanoke River. All of these deposits are of varying value and have been worked to some extent. In parts, they are well developed, especially in Anson, Moore, Harnett, Halifax and Northampton Counties.

ANSON COUNTY

Along the Pee Dee River in this county in the Lafayette formation are found some valuable gravel deposits. These gravel deposits are chiefly on the west side of the river in a section of the Coastal Plain formation which overlies the crystalline rocks. The deposits are only a short distance east of the contact line between the older formation and the younger Coastal Plain formations.

The sand and gravel occur in lenses and beds from 10 to 40 feet thick. In most of the places they are covered by an overburden ranging in depth from 10 to 20 feet. The deposits cover about 300 acres, part of which has been worked. Only the richer portions of the deposits—those 10 feet thick and over—are sought after. The gravel is a high grade material consisting of quartz and quartzite pebbles mixed in sand and clay. The pebbles range in size from three inches in diameter down to fine sand.

A washing plant of 50 carloads capacity per day is in operation. Washed sand and gravel are being produced. The gravel ranges in size from coarse sand to one-half inch; one-half inch to one and one-half inches; one and one-half inches to two inches. Thousands of cubic yards of good sand and gravel still exist in the deposits in this locality.

Six miles southeast of Wadesboro and one mile east of Bennett Station on the A. C. L. Railway some small deposits of sand and gravel are found. The deposits contain clay and sand and gravel. The pebbles range from three inches in diameter down to fine sand. The average depth is from two to six feet and covers about 30 acres. The deposit has been investigated by the A. C. L. Railway.

In the eastern part of the county small lenses of sand and gravel are found in the Coastal Plain formations. South of Wadesboro on Jones and other small creeks small deposits occur. About two miles southeast of Wadesboro where the A. C. L. Railroad crosses a small tributary of Jones Creek a very good deposit is found.

BUNCOMBE COUNTY

At two or three places in the French Broad River a good grade of sand is found. Just below the West Asheville Bridge a company is producing about 50 cubic yards per day.

The most important deposit of sand and gravel found in Buncombe County occurs on the north side of the Asheville-Black Mountain Highway near Swannanoa. This property is owned and operated by the Grove Sand and Gravel Company. The plant has a capacity of 1,000 tons per day. The material produced is used in construction work.

EDGECOMBE COUNTY

In this county some sand and gravel occur along the streams and in the old stream valleys. The most important deposits occur along the Tar River.

Near Tarboro where the Tar River makes a long curve there is a sandbar which supplies a great deal of high grade sand. At each freshet the sandbar is rebuilt thereby affording a continuous supply of sand. Also just to the southeast of Tarboro near the railroad bridge a very good building sand is found. The sand is composed chiefly of quartz, very clean and free from mica. One mile north of Tarboro on the inside of a curve in the Tar River a very extensive deposit of sand is

found. It ranges in depth from 4 to 10 feet and covers several acres. The sand is clean, hard and angular.

HARNETT COUNTY

Harnett County is the richest in gravel deposits of any county in North Carolina. Just east of the fall line and along the Cape Fear River are vast deposits that are quite rich. They very probably belong to the Lafayette terrace formation.

Up until 1920 these deposits were little used. At the present time, one of the largest gravel washing plants east of the Mississippi is located near Lillington. Other than this plant there are several lesser operations in that section.

One mile southwest of Lillington on the Atlantic and Western Railroad there is a deposit of sand and gravel which covers several acres. The property lies on the south side of the railroad and joins the right of way. The depth of the deposit is not great—from 4 to 10 feet—but it covers about 30 acres. The sand is coarse and angular and free from mica, clay and organic matter. The sand grains are chiefly quartz and overlies a clayey gravel.

Along Blacksmith Creek and on the nearby hills are deposits of gravel. The gravel varies in depth with an average of about five or six feet. Wells on the property show a depth at places of 15 feet. The gravel pebbles are composed of quartz, quartzite and some pebbles of unconsolidated quartzite. The majority of the pebbles are solid enough for concrete. They vary in size from sand to 2½ inches in diameter. The tonnage will depend on the proven depth. Due to its location, the property is for future development.

Three miles northwest of Lillington near the village of Summerville are large deposits of gravel. Some of these have been worked extensively by the Carolina Materials Corporation. The gravel consists of a mixture of pebbles and sand. The gravel pebbles are quartz and quartzite and vary in size from sand to two inches in diameter. The depth varies from 4 to 10 feet but does not average over 5 or 6. The finished product from this district is an excellent material for concrete and hard-surface roads.

One and one-half miles southwest of Lillington there are workable deposits of gravel. The gravel lies along both sides of the railroad. The chief properties lie in the Coastal Plain region near the western edge and near the Cape Fear River. The topography is rolling and well drained. The region has been locally much cut and worked over by the Cape Fear River and the deposits are mixed and irregular.

In these deposits are found gravel of fairly uniform size and composition. The gravel occurs in beds and ridges along both sides of the railroad for a distance of half a mile. The deposits are a part of the gravel hills that extend to the west and northwest of Lillington and vary in width. The depth varies from 10 to 20 feet deep. All along the railroad the gravel is good to the bottom. The gravel consists of quartzite and quartz pebbles in a mixture of clay and sand. The clay is more abundant than the sand in the mixture, so much so that it is difficult to wash. The pebbles are uniform in size and are not too large for road surfacing.

STANDARD SAND AND GRAVEL COMPANY, LILLINGTON, N. C.

The property of the Standard Sand and Gravel Company lies near the town of Lillington in Harnett County. The main line of the Norfolk-Southern Railroad passes almost parallel to the north end of the property and about 300 feet away. The property joins the town of Lillington on the west and extends almost to the Cape Fear River, half a mile away. It lies to the northwest along the south side of the Cape Fear River and into the gravelly hills section for a distance of two miles or more. The topography is medium rolling to hilly and well drained.

The region consists of shallow Coastal Plains deposits over basement rocks. These deposits consist of gravel, sand, clay and soil in varying amounts. These deposits are deepest in gravel at the north end and spread out and vary in thickness from 6 to 10 miles to the northwest. To the north and west beyond the river are deposits of gravel. These have all been deposited by running water.

The deposits worked are sand and gravel. These deposits occur in hills and ridges. The gravel being less easily eroded has been left in hills and ridges while the other things have been carried away. The deposits owned by the Standard Sand and Gravel Company cover an area of 800 acres. They vary in depth from 10 to 40 feet.

The deposits consist of gravel pebbles composed principally of quartzite and quartz and sand grains that are almost pure quartz. There is little clay in most of these deposits. The gravel and sand are easily washed and cleaned. In many of the deposits the amount of foreign matter is not over two or three per cent. The gravel and sand when washed make high grade materials for concrete, etc. On the property are a few deposits that are not of a washable grade. These are clay deposits and are being used for roads, streets, etc. Camp Bragg has used several thousand tons of this grade for the roads and streets around the camp.

The largest and most modern gravel plant east of the Mississippi in the South has been completed. This plant has a capacity of 2,400 tons of washed sand and gravel per day. The equipment consists of steam shovels for digging the gravel from the pits, cars and dinkey engines for carrying the unwashed gravel to the washer; tram lines to haul over. The washing plant is modern and complete. It consists of washers, crushers, elevators and screens for washing and sizing the gravel and storage bins to receive the washed product. Pumps and a water line bring 1,200 gallons of water per minute from the river one-fourth mile away into the washer to wash and clean the gravel and sand.

The treatment is simple and by machinery throughout. The gravel is dug by steam shovel, loaded into tram cars and dumped into a big hopper at the plant. The plant is in three units of 8,000 tons capacity each. The gravel is taken from the hopper by an apron feed and carried on belt conveyors to the three units of the plant—one or all three being used as the needs demand. Washers clean the gravel and sand. Crushers reduce the over-size. The gravel is then graded into three

sizes and the sand into two and each size dumped into a bin for receiving it.

The finished products are: concrete gravel, cementing gravel, roofing gravel, concrete sand and filter sand.

Operations at Lillington first began several years ago on a small scale. The Cape Fear Gravel Company operated a small washing plant. The work was on a small scale and the methods were not the best. The adventure was never successful.

In the spring of 1919 some capitalists became interested in these deposits. The Standard Sand and Gravel Company was organized with a capital stock of $500,000. The old Cape Fear Gravel Company was bought out and other lands were acquired, in all about 800 acres. Work was at once begun on the property and a modern plant is now operating.

HALIFAX AND NORTHAMPTON COUNTIES

Halifax and Northampton Counties have rather extensive but not deep deposits of gravel. The Lafayette formation is rather well marked in the section around Thelma and near Weldon. In this area and especially along the old valley of the Roanoke River there are large deposits of gravel. Some of these are being worked and show up well; others will also prove to be of value.

Near Thelma there are gravelly hills that are parallel to the river valley. There are several hundred acres of farm land underlain with good gravel. The topography is rolling to hilly and is deeply cut by two or three small streams. On the farm of Mr. B. M. Pugh the gravel shows a depth of from 15 feet on the tops of the ridges to 4 feet along the hillsides and valleys. The gravel is of the best grade and consists of well-rounded quartz and quartzite pebbles in a matrix of sand and clay.

The sandy portions of the gravel can easily be washed or screened. It will take washing tests to determine whether the clayey portions of the gravel can be successfully washed. Screening tests have been made on the sandy portion of the deposit with success. Several hundred yards of this sand and

gravel were screened and used in concrete in making the piers on which the railroad bridge was built across the Roanoke River at Gaston. About one mile from this deposit is another deposit which contains two or three hundred thousand yards of high grade material. If it can be successfully washed it will be of great commercial importance. It is well situated and the water for washing can be had in abundance.

On the north side of the Roanoke River in Northampton County are several deposits of gravel of economic value. These gravel deposits lie parallel to the river along the rolling and hilly area that marks the border between the river valley and the uplands. The deposits on the north side of the river are deeper and, therefore, of more value than those on the south side in Halifax County.

The first of these deposits are found three miles north of Thelma. Beginning at the upper edge of the so-called "second low grounds" about two miles north of the river bridge and extending to Vultare, a small station on the railroad, there are 60 or 70 acres of gravel on this property. On the southwestern end of the property are several acres on which a sand gravel is found. The gravel is a white quartz and quartzite material and varies in size from one inch down to sand. This gravel could easily be washed and graded into sizes for concrete and roofing gravel and sand. The depth is not great and the amount that can be had will not justify extensive operations.

The other part of the property is covered with deposits of clay gravel. Along the railroad cut the gravel shows a depth of 12 to 16 feet. The lower part of the deposit is richer than that near the surface. The depth below the railroad bed is not known. This gravel consists of white quartz and quartzite material varying in size from three inches down to one-fourth of an inch. The pebbles are well rounded and are bound together by a very plastic tenacious almost white clay.

About two and one-half miles north of the river bridge there is a cut about a half mile long and from 4 to 20 feet deep. This cut shows gravel exposures the whole length and depth of it. About the central part of this cut a pit was opened

and several carloads were taken out. This gravel proved too clayey for railroad ballast. Some 20 carloads were sent to Franklin, Virginia, where it was tested for gravel walks and for streets in comparison with concrete. Small amounts have also been used on the streets of Thelma. In both towns the gravel is giving satisfactory results.

Whether or not this gravel can be washed is to be proven by future tests. At the foot of these gravel ridges along the border of the river low-grounds several carloads of washed material are gathered each year. The rains and running water separate the gravel from the clay and this gravel accumulates along the foot of the ridge. From that part of the deposit that is near enough the railroad to bring this assorted gravel to the railroad track in drag scrapers the Camp Manufacturing Company collected 20 carloads of washed material each year. One-half mile further north near the station of Vultare is another small pit from which ballast was taken. This part of the deposit is a sand gravel and well suitable for railroad ballast or for washing. But this is on the northern end of the deposit where the gravel is getting thinner and the deposits here are not very deep. This deposit of gravel is convenient to the railroad and if it can be washed an abundance of water can be had for washing.

One and one-half miles northeast of Garysburg and one mile east of the S. A. L. Railway is a gravel property and washing plant of the Sam Lawrence and Company of Raleigh, N. C. The gravel occurs along a rolling and hilly area on the north edge of the Roanoke River valley. The topography is rolling enough to be well drained and local streams furnish an abundant supply of water for washing purposes. A spur track has been built from S. A. L. Railroad to this property, a distance of about one mile.

The property consists of from 75 to 100 acres of gravel deposits which contain two to three thousand cubic yards. The gravel varies in depth from 15 to 20 feet and consists of both sand and clay gravel. The gravel itself is a quartz-quartzite material ranging in size from three inches in diameter down

to coarse sand. The average size is from 1½ inches to ¼ inch in size.

A washing plant is in operation on this property. The washer consists of a small portable outfit capable of washing about 15 cars per day. The gravel is dug from the beds by a drag line and emptied from the dipper directly into the hopper of the washer. A stream has been dammed on one edge of the property and a central pumping station furnishes water to the washer in about a 4-inch stream. This plant is being operated primarily for railroad ballast and makes no attempt to grade the gravel to different sizes. The plant furnishes about 15 cars a day of a mixture proportioned two of gravel to one of sand. In connection with this a considerable amount of commercial sand and gravel for concrete is furnished and also some unwashed clay gravel for highways. The total production of this plant is 150 thousand tons per year.

In the northern end of Halifax County between Weldon and Littleton are found extensive but not deep deposits of gravel. These deposits occur parallel to the Roanoke River on the rolling hills and ridges that mark the borderland between the upland and present river valley. These deposits vary from one to three miles distance from the river. No attempt was made to study these deposits in detail as they are not deep enough to be worked on a commercial scale. Several pits have been opened in this part of the county to get material for local road building. The gravel was all used as a clay gravel for road surfacing no attempt being made at any place to wash the gravel for concrete use.

At Summit, a flag station on the S. A. L. Railway about a mile and a half west of Thelma, there is an old gravel pit that was opened several years ago by the S. A. L. Railway Company for ballast. The pit was opened two or three hundred feet from the railroad track and a side track built to the pit. The gravel averages about six feet deep. The gravel proved too clayey for railroad ballast and as it was too clayey to wash, the pit was abandoned. Later the property fell into the hands of Hammel Brothers of Thelma. The clay in this gravel is plastic

and tenacious enough to make a good binder for road surfacing. The road from Thelma by Summit toward Littleton has been surfaced with gravel from this pit and is considered a very good road.

Between Thelma and Roanoke Junction several small pits are found alongside the county road. These pits have been opened in gravel that varies from three to five feet in depth. The gravel is a clay gravel and has all been used locally as a road surfacing material. One of the most important of these pits is located one mile east of Thelma on the Thelma-Roanoke Junction Road. This pit was opened in gravel about four feet deep. A large amount of gravel from this pit has been used for surfacing the road between Thelma and Roanoke Junction. Between this pit and Roanoke Junction are several small pits, none of which are important commercially. The gravel is extensive but the deposits are not deep. The gravel contains a clay that is an excellent binder. The gravel has proved satisfactory as a surfacing material.

About 2½ miles west of Jackson on the farm of Mrs. B. H. Hardy is a small deposit of gravel. The deposit of gravel is located about 1½ miles west of the N. & H. Railroad. The nearby topography is very flat, so much so that rain water does not readily run off. The gravel occurs along a slight ridge that extends in a nearly north-south direction and does not rise more than three or four feet above its surroundings.

The deposit is about 1½ acres wide and about 10 acres long, containing about 15 acres. Along the center of the deposit the gravel varies in depth from 4 to 15 feet. These depths were ascertained from some old wells and an old pit on the property. These did not show the total depth. How much greater the depth is, it is impossible to say. The gravel itself is a well-rounded quartz and quartzite material mixed with sand and clay. The pebbles vary in size from 1½ inches down to ordinary sand. The surface layer of three or four feet in depth is a sand gravel and will easily wash. Below this depth the clay content increases and whether it can be washed or not will have to be determined by experiments. If

the gravel can be successfully washed it will make an ideal concrete and roofing gravel.

The deposit is located within a half-mile of the railroad and an old tram line for lumbering once crossed the southern end of the deposit. A railroad is the only practical way for removing this gravel as it lies two miles from the road and will have to be reached over a road that is impassible half of the year. The deposit is further handicapped by not having an abundant and accessible supply of water nearby.

JOHNSTON COUNTY

Johnston County is crossed by the Lafayette terrace formation. In this formation along Neuse River just west of Smithfield and near Selma are deposits of gravel that are of local value. These have been used only to a limited extent.

About two miles west of Selma on both sides of the Southern Railway there are good deposits of sand. It lies about one mile east of the Neuse River on a low flat ridge that rises to an elevation of only a few feet above the river valley to the west. The topography is slightly rolling and is well drained.

The principal sand removed is for foundry purposes. This foundry sand is overlain by 12 to 15 inches of soil. Below this is a layer of from three to five feet of foundry sand. Below the foundry sand is a grade of sand that can be used for filler and like uses. This grades into a clayey gravel. The deposits on the north side of the railroad cover an area of about 10 acres. This property has been worked over about 10 acres. On the south side of the railroad the deposits have not been tested for depth, grade, or extent, but sand of the same character as that shipped occurs over several acres.

The sand is an excellent quality for core and car wheel castings. It has a strength for moldings up to 28,000 pounds in weight. This sand goes principally to the A. C. L. and N. & W. Railroads and is sent to four States, North Carolina, South Carolina, Virginia and Georgia.

The sand is being worked as a by-product of farming. The soil is moved to one side and then three or four feet of sand

removed. The soil is then redistributed and the field again cultivated. The elevation is high enough to be easily drained, after the sand is removed. The sand is loaded into cars mostly by hand. The soil is removed by wheels and scrapers. The sand is then taken up by these scrapers and carried on a platform by the siding that is on the same level with the car doors. The sand is then loaded into the cars with hand-shovels. The annual production of foundry sand has been very large. Some filler and concrete sand is also shipped.

About one mile west of Selma, Johnston County, is a very good gravel deposit. The property lies along the southern boundary of the Southern Railway about one mile west of the crossing of the Southern and A. C. L. Railways at Selma. A side track from the Southern Railroad has been built into the property. The property lies about two miles east of Neuse River in the western edge of the Coastal Plain. The section is only slightly rolling, but being near Neuse River is well drained.

The geology of the region consists of shallow deposits of sand, clay and gravel with exposures of older basement rock. To the west and along Neuse River old rocks are exposed. The immediate section consists of deposits of sand clay and gravel. The gravel deposits lie along the east side of a small stream in ground that is almost level. The deposits are found over 40 or 50 acres of land partly wooded and partly in cultivation. The deposits have been worked from 10 to 15 feet deep. A pit rather irregular in slope and extending in a north and south direction has been opened.

The gravel is a sand and clay gravel. The composition varies in different parts of the deposit. The operation was carried on by the Southern Railway Company. The gravel was used for ballast. The more sandy, porous grades were sought and the clayey grades were left in the pit. Some of the clayey grade has been used for road surfacing and has proved to be of excellent quality. The pebbles are mostly quartzite and quartz and vary in size from one inch down to coarse sand.

No attempt has been made to clean and concentrate the gravel. A siding was built into the pit and gravel was loaded

direct into railroad cars by a steam shovel. The sandy gravel best suited for ballast was taken and the clayey sections were left. Some of the clayey gravel has been used locally for road surfacing. The Selma end of the Selma-Smithfield road was surfaced with about eight inches of this gravel. For a long time it was the best road in Johnston County. The tonnage is ample for working on a small scale. The production has been about 30,000 cubic yards of unwashed material per acre.

The material is of doubtful washable grade. If washing proves possible, plenty of water can be had from streams nearby. For unwashed ballast and clay gravel the deposit will furnish an abundant supply for local use.

In Johnston County south of the Southern Railway near Smithfield there are local deposits of gravel that are good. Most of these deposits occur along the rolling, hilly region to the west of the Neuse River. The deposits are shallow—3 to 10 feet deep—but are locally important.

About six miles north of Smithfield there are other very good local deposits of gravel many of which have been worked in the past. A number of smaller deposits similar to the above are found at different points across the county along the rolling lands two to five miles west of the Neuse River.

LENOIR COUNTY

Lenoir County has been more prospected for sand than any other eastern county. The deposits are rather extensive and rich. The old valley of the Neuse River is about three miles wide in the vicinity of Kinston. In this valley plenty of good sand is found. Several pits were opened in the course of the construction of several miles of concrete roads. Plenty of good sand was found.

A sand pit of Martin Brothers is located one mile south of Kinston just across Neuse River on the south side. The pit is about one mile distant from both the Norfolk & Southern and A. C. L. Railroads.

The pit is located in the Neuse River valley just above the flood line. The sand was deposited as the old river filled in.

The sand consists of several grades, ranging from small gravel to ordinary plaster sand. It is angular and free from mica and organic matter.

A pit has been opened to an average depth of 20 feet and extends over three to four acres. The deposit of sand covers several acres. For several years this pit has been furnishing 90% of the sand used in and around Kinston.

About one mile west of Hines Junction near the Norfolk-Southern Railroad and near the school for the feeble-minded, there is a large sand pit used by R. L. Blalock, Constructor, of Kinston. The pit lies about a mile north of Neuse River and in the old river valley. The sand has been deposited by running water in the old valley. It varies from coarse concrete sand to plaster sand. A good-size pit has been opened. Several thousand tons of this sand was used in rebuilding the school for the feeble-minded. It is also extensively used in building projects in and around Kinston.

On the east edge of the town of Kinston, about one mile from both the Norfolk & Southern and Atlantic Coast Line Railroads, is an old sand pit. Two grades of sand—a coarse and fine—are found here. The coarse sand has pebbles up to 3/8 inch in size. The finer sand is fine enough for sheet asphalt filler. The sand is a clean more or less rounded sand composed largely of quartz pebbles. The sand is nearly white but under a lense the individual grains show some coloring. This sand has been used around Kinston for building purposes and for concrete blocks. The West Construction Company has used about 50,000 tons of sand from this pit for building concrete roads in Lenoir County and for sheet asphalt.

MOORE COUNTY

Moore County is locally and generally well supplied with gravel and sand. The deposits may be divided into two groups; those around Carthage and along Little River southeast of Carthage, all of which lie east of the Triassic (brown sandstone) area and those west of the Triassic formation—that is those about 10 miles west of Carthage. These exposures are of one group and probably belong to the Lafayette formation.

The more important of the two divisions is that near Carthage and extending in an irregular and broken line to the south and southeast. The first gravel of importance is found 1½ miles northwest of Carthage. The deposit continues in an irregular outline for a distance of about four or five miles in a southeast direction from Carthage. It varies in width from ½ to 1½ miles. This gravel consists of rounded pebbles of quartz and quartzite and sand which occurs as coverings 1-12 feet thick along the tops of the highest hills and ridges.

The deposits that occur west of the sandstone formation begin near Hallison and extend south of Fay and Mt. Carmel. They vary in width from ½ to 2 miles and are about 10-12 miles long. They consist of semi-rounded and crushed quartz mixed with soil, sand and clay and occur along the tops of hills and ridges.

On the southeast side of Carthage the gravel consists of white to orange-colored quartz and quartzite pebbles well rounded mixed with a quartz sand. The gravel is clean and easily washed. In places the deposits run as high as 70% gravel, not counting sand. Both gravel and sand are of high quality.

Two miles southeast of Carthage and just beyond the property of the Carolina Sand & Gravel Company is an old sand pit. The gravel is a continuation of the above deposit but poorer. Near the main road from Carthage to Cameron, there are large deposits of gravel averaging 4-6 feet deep.

The gravel is a mixture of quartz and quartzite pebbles in sand and clay. The first two feet of the deposit consists of sand and gravel. Below this depth clay gravel is found. The gravel makes a good road material. Large quantities for local use can be obtained here.

One mile west of Carthage at the J. F. Cole tin shop is a large hill covered with gravel. This hill is the western end of the deposits which the Carolina Sand & Gravel Company operated and a continuation of the ridge on which Carthage is built. Gravel deposits several acres in extent are found here. The depth varies around 4-6 feet. The gravel consists of a

mixture of sand, clay and gravel and can be easily worked. The deposit is important locally.

On the farm of J. F. Hayes two miles southeast of Carthage are 30 to 40 acres of land on which gravel is found. The gravel varies from two to eight feet in depth. A small pit was opened and operated by the county road force. The gravel is mixed with sand and clay and serves well for road material. A large supply for local use can be obtained.

In the general section around Black's Mill and Blue, a local station on the Norfolk & Southern Railway, six miles southeast of Carthage, local deposits of gravel occur. The most important deposits occur on the farms of T. D. McLean and Dick Fry and others. This gravel is much like that near Carthage. It consists of well-rounded quartz and quartzite pebbles mixed with sand and clay. These local deposits have been used to a small extent.

Ten miles west of Carthage near the old postoffice of Fay, some small pits have been opened on the farms of A. A. Muse and Dowdy Brothers. The gravel in this section is not as abundant as near Carthage and is not as well rounded and sorted. It is a good road surfacing material and in sufficient amounts to be of importance for local use. The deposits here are about one mile wide and vary in depth around three to five feet. The gravel consists of angular and rounded quartz in clay, sand and soil.

On the farm of A. A. Muse the deposits are exceedingly abundant for local use. In the Mt. Carmel section other deposits are found. All of these are important locally, but none of them can be considered as of commercial value.

WILKES COUNTY

All along the Yadkin River from the boundary of Forsyth County westward to North Wilkesboro and beyond an abundance of sand is found. Most of this sand was put down in the flood of 1916. Much of it is too fine for ordinary concrete use. However, locally, there are deposits that are very good. Besides concrete sand, much fine sand for sheet asphalt and

filler can be obtained. Sand has been worked in several places along the river.

About five miles east of North Wilkesboro there is a deposit which has been partly worked which covers about 40 or 50 acres immediately along the north bank of the Yadkin River between the Southern Railway and the river. At this point the river makes a curve to the south. Along the inside of this curve the sand has been deposited. The sand is very coarse—much more so than any found along the river at other points. Deposition has gone on here for a long time and this point being inside the curve caught the coarse sand while the finer was deposited higher up on the bank.

The sand here is a very coarse sand composed of quartz and quartzite grains. It is clean and white and is free from injurious impurities. On the property, concrete sand, sheet asphalt and filler sand are found. A railroad siding is built through the property and several cars can be loaded each day.

WAKE COUNTY

Wake County has little gravel and sand. A few small deposits are found along the fall line and near streams. There is one good deposit of crushed quartz near Garner.

In the southwestern section of Wake County are several deposits of gravel that are of local importance. None of these deposits are great in extent or in depth. They lie along the streams in the rolling sections of the southwestern portion of the county. In sections they are being used for local road building and local construction.

One of the deposits that has been to some extent used lies about one and one-half miles from Cardinas, a point on the Norfolk & Southern Railway. The gravel lies mostly along Terrible Creek and is found on the property of Ballentine Brothers. Gravel shows several hundred acres.

The deposits are found in the Coastal Plain region but being on the western edge of the Coastal Plain the topography is rolling and well drained.

The gravel lies on the ridges and along the tops of the hills that are largely parallel to the streams. The deposits are not continuous but occur in small areas that have been left in the process of erosion. The deposits vary in width from one hundred feet to three or four hundred feet and are up to several feet in length. The average depth is three to five feet.

The gravel consists mostly of a mixture of water-worn pebbles in clay. The pebbles are quartz and quartzite. The mixture is such as to make an excellent road material.

This gravel is not washable and cannot be considered important for anything except roads. The distance from the Norfolk & Southern Railway is not great, but the supply is too small for stripping. For local use it is adequate and is so well located that it can be used to a great advantage and not have to be hauled over one to three miles.

About one and one-half miles southeast of the Southern Railway there is a 30-acre deposit of quartz gravel. The deposit has been tested to a depth of 12 feet. The gravel is a crushed quartz and is probably much more than 12 feet deep. One side of the deposit consists of a nearly solid quartz ledge. The other part of the deposit has been much crushed and in places more or less cemented together. There is an abundant supply of this material ranging from one-half inch to ordinary sand.

The finer part of the gravel has been used locally and in Raleigh to some extent. It has been screened by hand and used locally for cement blocks for building purposes, and in Raleigh for roofing gravel. Some dirt is mixed with it and it will be necessary to wash or screen it. Plenty of water for washing can be had from a nearby stream. While a part of the gravel is fine enough for use as it occurs in the deposit, it will be necessary to crush large parts of it to the proper size.

The gravel is a high grade quartz and very free from iron and impurities or stains of any kind.

The property is more than a mile from the railroad and no siding connects it. But a right of way has been secured

and a railroad can be built with little trouble. This deposit should be a valuable one.

In the western counties there are no extensive sand and gravel deposits, but there are many local deposits which may be worked commercially. The gravel deposits of these counties occur principally along the main stream valleys and in the stream terraces, caused by the streams meandering across the broader valleys. To describe the deposits of each county separately would require a great deal of time and space. Only the more important ones are mentioned, and they only briefly.

Most of the counties along the foot of the Blue Ridge Mountains, as Polk, Rutherford, McDowell, Burke, Caldwell, Wilkes and Surry, have more or less stream gravel deposits. The gravel in all of these counties are composed of quartz, quartzite and rounded fragments of the old crystalline rocks. They vary in size from sand to large boulders. In most of the deposits the gravel would have to be crushed, washed and screened before being suitable for the various trades. No real good quartz gravel deposits as those just below the fall line are found. Only occasionally are deposits found where the gravel is anything like uniform. As a result of this condition, the deposits have not been worked to any extent. And, too, there are so many exposures of rocks of different varieties which are easily quarried for the various trades. The principal types of crushed stone used are granites, gneisses, quartzites, trap, marbles and limestones. A great amount of these kinds of crushed stone are used in road building and dam construction.

MOUNTAIN DISTRICT

BURKE COUNTY

In this county, especially along Silver Creek, there are commercial deposits of sand and gravel. On the headwaters of this creek a great deal of quartz is mixed in the gravel but no true quartz gravels are found. At times the material is quite angular while at others it is well rounded.

CLAY COUNTY

Along the Hiwassee River below Hayesville there are river gravels which may be used locally. It would take considerable prospecting and drilling to determine the value. Occasionally sand suitable for concrete work is found as bars in the river.

CATAWBA COUNTY

In this county, principally along the Catawba river, there are very good deposits of sand and gravel. Just below where the Southern Railroad crosses the Catawba River there are large deposits of sand deposited during the 1916 flood. A great amount of sand was shipped from this area. Also below the rapids on the south side of Highway 10 where the road crosses the river there are large sand bars of very good sand.

McDOWELL COUNTY

Along the Catawba River between Old Fort and Marion there are numerous deposits of gravel, many of which offer possibilities. However, before the real value could be determined a great deal of prospecting would have to be done. Along Buck Creek there are also deposits of gravel which show up well.

RUTHERFORD COUNTY

In this county along Broad and Second Broad Rivers there are gravel deposits of possible economic value. These gravels are principally rounded fragments of the crystalline rocks and vary in size from sand to large boulders. They occur chiefly along the river bottoms.

Other than the above counties, there are others in which, especially along the streams, that gravel and sand deposits occur which are of local value.

Production

The production of sand and gravel continues to rank third in value. The production in 1927, however, was less than that of 1926. In 1928 the total value of production was the lowest on record since 1921.

PRODUCTION OF SAND AND GRAVEL IN NORTH CAROLINA FROM 1923 TO 1927, INCLUSIVE

Year	Quantity (short tons)	Value
1924	1,112,650	$889,050.
1925	1,108,035	886,351.
1926	1,434,839	968,021.
1927	1,462,808	871,416.
1928	971,746	531,092.

PRODUCERS OF SAND AND GRAVEL IN NORTH CAROLINA IN 1927 AND 1928

Name of Company or Producer	Address	Plant Location	
		Town	County
W. R. Bonsal Company	Hamlet	Lilesville	Anson
Hedrick & Wade, Inc.	Lilesville	Lilesville	Anson
Grove Stone & Sand Company	Asheville	Swannanoa	Buncombe
Norfolk & Southern Railway Company	Raleigh	Newport	Carteret
Zimmerman Brothers	Winston-Salem	Winston-Salem	Forsyth
Southern Sand Company	Sanford	Lillington	Harnett
L. C. Nix	Hendersonville	Hendersonville	Henderson
Frank W. Elliott	Statesville	Statesville	Iredell
Marshall Sand Company	Black Mountain	Marshall	Madison
R. C. Belk Sand Company	Charlotte	Charlotte	Mecklenburg
Pat Harmon	Candor	Candor	Montgomery
Aberdeen Sand Company	Aberdeen	Aberdeen	Moore
Atlantic Coast Line	Wilmington	Garysburg	Northampton
Lawrence Stone & Gravel Company	Raleigh	Garysburg	Northampton
Second Broad River Sand Company	Johnson City, Tenn.	Forest City	Rutherford
Jobe Brothers	Coeburn, Virginia	Logan	Rutherford
J. T. Rich	Garland	Garland	Sampson

STONE

There is probably no State in the Union which has a greater variety of stone than in North Carolina. The State has practically every type of building, structural, monumental and ornamental stone to be found. The types of stone found are the white, pink and gray granites; the stone allied to granite, as rhyolite, diorite, trap, etc.; several varieties of gneiss; white, "Confederate gray," pink, mottled, "regal blue" marble; several varieties of limestone and dolomite; quartzite; gray and red sandstone; serpentine and volcanic slates.

Production

PRODUCTION OF BUILDING STONE IN NORTH CAROLINA FROM 1924 TO 1928, INCLUSIVE

Year	Granite	Marble limestone and Marl	Total
1924	$3,001,615.	$336,590.	$3,338,205.
1925	2,865,040.	825,486.	3,690,506.
1926	3,847,062.	338,811.	4,285,873.
1927	4,454,468.	478.224.	4,932,692.
1928	4,416,518.	342,786.	4,759,304.

GRANITE

The granites of North Carolina are distributed over about one-half the total area of the State, but the productive part of this area is considerably less. Openings from which granite has been quarried in the past have been made in a majority of the counties where it occurs. The chief producing centers at the present time are in the counties of Rowan, Surry and Vance. In Rowan County, the "Salisbury pink" is produced. In Surry, the "Mt. Airy" granite is the chief variety found. These two varieties of stone are well known throughout the Eastern United States.

Geographically, the distribution of the granites, gneisses and allied stone is in the three larger physiographic provinces of the State, namely, the Coastal Plain, the Piedmont Plateau and the Appalachian Mountains. However, the largest part of the granites are comprised within the limits of the Piedmont Plateau region. Smaller workable areas of massive granites, usually of excellent grade, are distributed through a number of the counties of the inner margin of the Coastal Plain, especially in the counties of Nash, Wilson, Johnston and Wake. The large areas of granite rocks of the mountain region are usually schistose in structure and cannot be used for certain high grades of work in which the granites are used.

The granites of the Coastal Plain area are the massive biotite rocks varying from fine even-granular to coarse porphyritic in texture and from gray to pink in color. Usually jointing is rather well developed in the granites, intersecting the rock in several general directions. Due to this excessive joint-

ing very few quarries have been opened from which large blocks of structural stone have been produced; consequently, most of it is used in the crushed form.

In the Piedmont section the texture of the granites varies from fine to medium, rarely coarse, and the color from nearly white through the lighter to darker shades of gray. A very beautiful shade of pink granite is quarried in several places in the vicinity of Salisbury. Over most of this area the granite shows more or less distinct evidence of the effects of intense dynamic-metamorphism.

In the mountain region the granites, both massive and schistose in structure, are quite widely distributed. More often they are schistose in structure and are usually biotite-bearing. The gneisses are of both sedimentary and igneous origin. In addition to the acid rocks, massive and schistose basic igneous rocks are found in places over the entire region. At times these rocks are found in large enough quantity and of such character as to make them of value for certain uses.

During 1927 there were 29 operators who quarried in 17 counties of the State. The value of the 1927 production was $4,454,468, or an increase of $607,406 over that of 1926. In 1928, the production of granite and allied stone fell to $4,416,-518. This production includes granite, rhyolite, trap and other crushed stone used in concrete.

USES OF GRANITE PRODUCED IN NORTH CAROLINA IN 1927

Use	Tons	Cubic Feet	Value
Building Stone	14,140	171,260	$594,800
Monumental Stone	6,610	80,160	348,427
Paving Blocks	32,970	------	196,074
Curbing and Flagging	36,420	------	685,183
Concrete	1,734,770	------	2,518,940
Other Purposes	--------	------	111,044
Total	1,824,910	251,420	$4,454,468.

PRODUCERS OF GRANITE IN NORTH CAROLINA IN 1929

Name of Producer	Address	County
Hiddenite Crushed Stone Company	Hiddeninte	Alexander
County of Buncombe	Asheville	Buncombe
Grove Stone & Sand Company	Asheville	Buncombe
Catawba Construction Company	Granite Falls	Caldwell
Collins Granite Company	Pelham	Caswell
F. L. Wagner	Shelby	Cleveland
Salem Quarries	Winston-Salem	Forsyth
Raleigh Granite Company	Raleigh	Guilford
Interstate Amiesite Company	Balfour	Henderson
Henderson County	Hendersonville	Henderson
Carolina Crushed Stone Company	Charlotte	Mecklenburg
Charlotte Granite Company	Charlotte	Mecklenburg
Harris Granite Company	Salisbury	Rowan
Peeler & Fraley	Faith	Rowan
Harris Granite Company	Salisbury	Rowan
Central Contracting Company	Salisbury	Rowan
Salisbury Granite Company	Salisbury	Rowan
Collins Durax Company	Faith	Rowan
Hardaway Construction Company	Salisbury	Rowan
North Carolina Granite Corporation	Mt. Airy	Surry
Raleigh Granite Company	Raleigh	Vance
Carolina Road Granite Company	Wilson	Wilson

MARBLE AND OTHER FORMS OF LIMESTONE

The marble deposits occur chiefly in Macon, McDowell and Cherokee Counties in the extreme southwest corner of the State. It occurs in a sort of lens varying in width from 1,000 to 2,500 feet and extends for a distance of 23 miles. Within the past year considerable core drilling near the center of the deposit has been done by a newly organized company which expects to develop the marble on a large scale. Before drilling was started it was thought by all who had visited the district that the marble was too much jointed to be of value as a building stone. However, the drilling revealed that little jointing occurred on the north side of the deposit. In the blue variety, blocks 28 feet thick without a flaw, were found. In the white, blocks 17 feet thick were revealed.

Recent tests prove that the marble ranks among the best found in America. The tensile and compression strengths are high while the absorption is very low. Due to the low absorption qualities, the marble is practically unstainable. Tests revealed that oils, greases, and organic juices did not pene-

trate the surface. As a result such materials, even after several days' exposure, could be removed with little effort. A number of tests made by the Bureau of Standards and the Massachusetts Institute of Technology on the fine grained white variety proved that it ranked with the Carrara marble for most uses.

LIMESTONE

Many varieties of limestone occur distributed over the State. In the eastern or Coastal Plain area a great number of deposits of marl, shell-rock and limestone occur. These materials are used at present principally for lime purposes. The true limestones occur in Swain, Henderson, McDowell and Madison Counties. Four plants are in operation at the present time producing crushed stone, lime and hydrated lime.

DISTRIBUTION OF MARBLE, LIMESTONE AND MARLS IN NORTH CAROLINA

These materials are usually considered together as they are very closely related chemically. The value of the materials depends to a very large extent on the chemical composition. However, the value of marble and limestone for dimension stone depends upon the color, the absence of flaws, as cracks, stains and impurities, and the size of blocks which can be quarried. There are few locations in the State where any of these materials occur which are pure enough for Portland cement. For Portland cement purposes there must be a high calcium carbonate content.

Marble and limestone occur in a great number of places in the upper Piedmont and Mountain sections of the State while the marls occur in the Coastal Plain deposits.

BUNCOMBE COUNTY

There are two deposits between Cane Creek and Arden in the southeast corner of Buncombe County. The overburden is 15 to 30 feet thick and little or no limestone is exposed. The material is similar to that quarried southwest of Fletcher in Henderson County.

CATAWBA COUNTY

There is a lense of dolomitic limestone which extends from Maiden northeastward to the Catawba River. At two or three places along the belt limestone has been quarried from time to time. About one-third of the material is magnesium carbonate and 30% insoluble material.

CHEROKEE COUNTY

The most extensive marble and limestone deposits in the State occur in this county and is known as the "Murphy Marble." The colors are white, dark blue and "Confederate gray." It occurs in a narrow band along the Notlely and Valley Rivers for nearly the entire length of the county. The composition varies from high calcium to high magnesium carbonate. It is suitable for tombstones, building and crushed stone and lime. The supply is unlimited.

CLAY COUNTY

The marble deposits of this county occur along Peachtree Creek and near Brasstown in the western part of the county. It is too much fractured and too impure for marble quarrying.

CLEVELAND COUNTY

A crystalline limestone belt in this county forms a linear group of narrow bands extending across the eastern part of the county, one-half mile east of Kings Mountain. A few quarries have been opened along this belt. The material is not of very high grade.

GASTON COUNTY

The limestone in this county is an extension of the belt which occurs in the southeastern part of Cleveland County. It is too far from the railroad to be of commercial value.

HENDERSON COUNTY

A lense of limestone occurs in the northwest part of the county, extending from the Transylvania County line in a northeast direction to one mile west of Fletcher. The only quarry is near Fletcher. It is a high calcium limestone.

JACKSON COUNTY

Impure crystalline limestone or marble exists at Caney Fork but is so remote from the railroad at the present time that it is of no commercial value.

LINCOLN COUNTY

A dolomitic limestone occurs four miles to the east and southeast of Lincolnton. This limestone was mined to be used as a flux when iron ore was mined in that section.

MACON COUNTY

In this county near Red Marble Gap there occurs a very large deposit of pink marble. The exposure occurs as a cliff 150 feet high and blocks of almost any size can be obtained. The texture is fine and it acquires an excellent surface to polish. Near the headwater of Ellijay Creek a high calcium limestone occurs, but it is too far from the railroad to be of commercial value at the present time.

MADISON COUNTY

In the vicinity of Marshall and Hot Springs there are lenses of high calcium (84%) and high magnesium (42%) limestone. Some of the lenses are 1,000 feet thick and can be traced for a great distance. This area is the chief producing center of the State.

McDOWELL COUNTY

Limestone occupies three areas in the northern part of the county along or near the North Fork of the Catawba River. The northernmost and longest area extends along the river from a few miles south of Linville Falls village to the vicinity of Sevier Station. Another more or less circular area occurs near Woodlawn. The third area is at the bend in the river two miles southeast of Woodlawn. It is white to gray in color and contains 52 to 62% calcium carbonate, 33 to 41% magnesium carbonate.

MITCHELL COUNTY

The only deposit of marble or dolomitic limestone occurs on the north bank of the North Toe River near the mouth of

Sinkhole Creek about 3½ miles above Toecane Station. This property was drilled by the C. C. & O. Railroad. The marble contains about 55% calcium, 45% magnesium and varies from white to dark gray. It is on the railroad.

STOKES COUNTY

Near Germanton is a bed 40 to 50 feet thick of limestone which was quarried and burned into lime prior to the Civil War. It is of indefinite quantity and quality.

SWAIN COUNTY

Along the Murphy Branch marble forms a continuous area from a mile south of Nantahala Station to a point ¾ mile northeast of Hewitts Station. The color is from gray to black and from cream white to pink. The formation is about 600 feet thick. Several quarries are operated for crushed stone only. The composition is from 50 to 98% calcium carbonate and from 10 to 42% magnesium carbonate.

Other than the above deposits there are thin and indefinite beds of limestone in Yadkin, Orange, Durham and Wake Counties.

MARLS

The marl deposits are rather extensive and cover a great number of the eastern counties. Only those deposits which may be used commercially are listed by counties.

BEAUFORT COUNTY

Near Washington and Chocowinity marl occurs beneath a slight overburden which shows from 56 to 81% calcium carbonate with an average of 60%.

BERTIE COUNTY

Near Avoca and Windsor, beds of marl occur which have been worked on a small scale. The calcium carbonate content varies from 28 to 63%.

BLADEN COUNTY

On Oyster Shell Ridge, marl six feet thick occurs. Four miles south of Elizabethtown and along Brick Yard Branch

four miles of Clarkton. The calcium carbonate content ranges from 44 to 94%.

BRUNSWICK COUNTY

Along Old Town Creek in the vicinity of Winnabow and El Paso very good marl occurs. Three and one-half miles south of west of Brunswick Ferry marl was dug for many years. The overburden is five or six feet and analyses show 87% calcium carbonate.

COLUMBUS COUNTY

In the vicinity of Bolton, Whiteville, Chadbourne and Fair Bluff, marl 12 feet thick occurs. The marl is sandy and contains from 30 to 60% calcium carbonate. Near Acme a marl plant operated for many years. The marl in this vicinity showed from 65 to 95.8% calcium carbonate.

CRAVEN COUNTY

Good marl occurs southeast of New Bern, near Riverdale; in Township One, Cowan Landing, Biddle Landing on Neuse River. Marl was produced for many years from deposits along Neuse River. Analyses shows from 89 to 94.5% calcium carbonate.

DUPLIN COUNTY

In the western central part of the county about 70 square miles are underlain with marl. Most of the marls dug come from Kenansville, Faison, Warsaw, Magnolia and Rose Hill. The analyses show from 30 to 90.74% calcium carbonate.

GREENE COUNTY

Shell marls, containing 50% calcium carbonate, occur near the surface along Sandy Run, near Roundtree, Castoria and Hookerton.

HALIFAX COUNTY

Near Halifax, along Quankey Creek, around Enfield, at Wrendale and Battleboro, near Tillery and Scotland Neck, near Palmyra, a bed seven feet thick has been worked from time to time. The numerous analyses show 36 to 87% calcium carbonate.

HERTFORD COUNTY

Marls with light overburden occur along Meherrin River and along the lower slopes bordering Wiccacon River and Potcasin Creek. It has been dug in vicinity of Latta, Murfreesboro, and Winton. The calcium carbonate content shows from 33 to 78% calcium carbonate.

JONES COUNTY

The most extensive and purest marls in the State occur along Trent River in this county. The best outcrops occur at Scott Landing, Mulberry Landing, Island Creek, Whitford Landing, Taylor's Landing and Pollocksville along the river. The marl varies in thickness from 10 to 22 feet and overlies shell which at times reaches 70 feet in thickness. The analyses show from 72 to 96% calcium carbonate.

LENOIR COUNTY

Along the south bank of the Neuse River, a belt of country 8 to 10 miles in width extending to Wayne County line is underlain by marls and shell rock of showing 70 to 80% calcium carbonate. Along Mill Branch, four miles south of Kinston, marl has been dug averaging 80% calcium carbonate.

NEW HANOVER COUNTY

Near Castle Hayne and on Smith Creek marl pits were operated many years. The thickness is from 12 to 15 feet, showing 35 to 70% calcium carbonate. Other localities are near Fort Fisher, Carolina Beach and along northeast Cape Fear River bank.

NORTHAMPTON COUNTY

Low grade marls occur at several places in the eastern half of the county. It never contains over 35% calcium carbonate.

ONSLOW COUNTY

Near Maysville and Belgrade marl has been dug for some years from a bed eight feet thick. On the Richland road from Jacksonville marl occurs. The marl shows from 37 to 66% calcium carbonate.

PENDER COUNTY

Near Burgaw and Watha, southeast of Ashton to New Hanover County line, marls occur. It has been worked on the McMillan property. Analyses show as high as 87.57% calcium carbonate.

PITT COUNTY

Marls are generally distributed throughout this county but the best deposits occur near Hanrahan and between Garnerville and Calico in Clayroot Swamp. Analyses show from 27 to 82% calcium carbonate in the marls.

ROBESON COUNTY

A low grade sandy marl, carrying about 50% or less calcium carbonate, has been dug from pits near Orrum, Ashpole, Fairmont, Lumberton, Rosendale and Councils. The beds of marl are very thin.

SAMPSON COUNTY

Marl deposits extend from the headwaters of Six Runs south to Lissa and Taylor's Bridge and westward beyond Clinton to Great Coharie Creek. Near Newton Grove, a small deposit occurs. Analyses show from 26 to 75% calcium carbonate.

WAYNE COUNTY

The best marls of this county occur near Mt. Olive in the extreme southern part of the county and has a thickness of between 20 and 25 feet. Calcium carbonate content varies between 40 and 80%.

WILSON COUNTY

Shell marl has been dug at numerous places along Toisnot and Hominy Creeks, and near Sharpsburg, as well as along White Oak Swamp. Analyses show from 38 to 72% calcium carbonate.

Production

The production of marble, limestone, etc., in North Carolina in 1927 was $478,224, or an increase of $139,413 over that of 1926. In 1928 the production decreased to $342,786, or $135,-458 less than that of 1927.

PRODUCTION OF MARBLE AND OTHER FORMS OF LIMESTONE FROM 1924 TO 1928, INCLUSIVE

Year	Value
1924	$336,590.
1925	825,486.
1926	338,811.
1927	478,224.
1928	342,786.

PRODUCERS OF MARBLE AND OTHER FORMS OF LIMESTONE IN 1927 AND 1928

Name of Company	Address	Plant Location	
		Town	County
Craven Contracting Company	New Bern	New Bern	Craven
Shell Rock Lime Company	New Bern	New Bern	Craven
B. & C. Lime & Stone Company	Asheville	Fletcher	Henderson
B. C. Buquo Lime Company	Hot Springs	Hot Springs	Madison
T. E. Love & R. E. Honeycutt	Stanfield	Stanfield	Stanly
N. C. Talc & Mining Company	Hewitts	Hewitts	Swain

TALC, PYROPHYLLITE AND SOAPSTONE

The talc deposits of North Carolina are confined to the mountain district. However, large deposits of a mineral similar to talc in physical properties occur in Moore County. This mineral is called pyrophyllite.

The most important deposits of talc which have been worked commercially in the past occur in a belt extending from near Hewitts, Swain County, in a southwestward direction into Cherokee County to the village of Kinsey. These deposits parallel the Murphy Branch of the Southern Railway and occur in lense-shaped masses varying in length from a few feet to about 1,500 and in width up to 100 feet or more. About 18 mines and prospects have been worked in the past. The most important deposits of this belt occur at Hewitts, Maltby and Kinsey.

Other deposits of talc which might prove to be of economic value occur in Yancey County about five miles to the north and east of Burnsville. Material from these deposits was used for tombstones, hearths and fireplace linings. Blocks several feet square have been mined at these places. These deposits

are within a mile of the railroad. A great many smaller deposits are found in Yancey, Mitchell and Avery Counties.

A deposit of soapstone suitable for tubs, sinks and table-tops occurs near Baldwin in Ashe County. This deposit has been worked to some extent in the past. Due to jointing, faulting and impurities in the soapstone, the company operating this property for the past few years closed down in 1927. However, since that time core drilling revealed some very good material.

PYROPHYLLITE

BY JASPER L. STUCKEY

Pyrophyllite (H_2 Al_2 Si_4 O_{12}) is a common mineral that is well known to teachers of mineralogy; but it is not commonly known as a mineral of commerce. North Carolina has the distinction of having within her borders the only known commercial deposits of this mineral in the United States. The physical properties of pyrophyllite are almost identical with those of talc and for this reason the two minerals have about the same uses. In the mineral production statistics pyrophyllite is usually classed along with talc, which probably accounts in part for its not being better known.

Just when pyrophyllite was first discovered in North Carolina is not known. It has been produced near Glendon, Moore County, since 1856 and important deposits have been located in other places in the State in recent years.

Deposits of pyrophyllite that are known to be of commercial value or seem to show indications of commercial value are found in the following counties: Moore, Chatham, Montgomery, Randolph, Orange and Granville.

MOORE COUNTY

Moore County contains the best known pyrophyllite deposits in the State. Some of these deposits, particularly those along Deep River, have been known and worked since 1856. Other deposits near Hemp on Cabin Creek were discovered in 1918 and have been found to be of commercial importance.

The deposits in this county may be divided into two narrow belts or zones not more than 600 to 800 feet wide which can be traced along the surface for several miles. The more important of these two zones begins on Indian Creek in Chatham County and extends in a southwest direction along Deep River a mile north of Glendon by McConnell to the point where the Norfolk-Southern Railroad crosses Buffalo Creek. On this belt are a number of deposits of importance.

C. L. Currie: About one mile north of Haw Branch where the road from Haw Branch to Harpers Cross Roads crosses the county line, prospecting for pyrophyllite has been done on the farm of C. L. Currie. A number of test holes show the presence of pyrophyllite.

A. J. Jones: About one-half mile southwest of the prospect referred to above, prospecting has been done on the farm of A. J. Jones. The test trench, which is in a thick woods, extends across the pyrophyllite beds some 100 feet or more. A much colored pyrophyllite free from grit is to be seen here. The prospect is promising.

Snow Mine: About one mile east of the road from Glendon to Harpers Cross Roads on Rogers Creek is the Snow Mine, or as is sometimes called, the Rogers Creek Mining Company's property. Here is a lense of pyrophyllite and pyrophyllite schist 500 feet wide by 1,500 feet long. An open cut 60 feet long, 50 feet wide and 30 feet deep was opened on the property about 1898. This property contains a large body of pyrophyllite that should prove valuable.

Womble Mine: One mile north of Glendon and immediately along the east side of the road is the Womble Mine. This mine was first opened about 1856 and is the oldest known in the State. The property on which pyrophyllite is found is about 600 feet wide by 1,800 feet long. On the northeast end of the property is an open cut 400 feet long, 40 feet deep by 75 feet wide. Numerous other pits, shafts and tunnels are to be seen on the property. Here is doubtless a large body of good pyrophyllite.

Phillips Mine: On the west side of the road immediately to the southwest of the Womble Mine is the Phillips Mine.

This property is known to contain a body of pyrophyllite some 1,500 feet long. It has recently been prospected by the United Talc and Crayon Company. This company has built a modern mill at Glendon, one mile away.

Bates Mine: About one-half mile southwest of the Phillips Mine is the Bates Mine. Here mining was carried on for several years. A mill was built and several openings made. Some good pyrophyllite was found, but the size of the body was not determined.

Jackson Place: About three miles southwest of Glendon on the Jackson place, prospecting for pyrophyllite was carried on several years ago. Several large open pits indicate the presence of pyrophyllite, but the importance of the outcrop is not known.

McConnell Mine: A short distance west of the postoffice of McConnell, prospecting for pyrophyllite was done several years ago. An open cut some 400 feet long still shows pyrophyllite. The size of the deposit is not known but it seems promising.

Southwest of McConnell as far as the Norfolk-Southern Railroad occasional outcrops of pyrophyllite are to be seen but nothing is known as to their value.

The other band of pyrophyllite in Moore County begins near Carter's Mill on Cabin Creek and continues to the southwest to Wet Creek near the State Highway. On this zone is one important deposit of pyrophyllite worth listing here.

Standard Mineral Company: About 2½ miles southwest of Hemp, the Standard Mineral Company is mining on one of the most important pyrophyllite deposits in the State. The outcrop which is about 150 feet wide can be traced along the surface for a distance of about one mile. The deposit was recently tested by diamond drilling. A body of commercial pyrophyllite 30 feet wide by 2,000 feet long which extends to a depth of 300 feet was found.

Sanders Property: Near where Cotton Creek enters Cabin Creek some five miles east of Star on the property of Mrs. Bettie Sanders, prospecting has shown the presence of pyrophyllite. Just how important the deposit may be is not known.

MONTGOMERY COUNTY

On Cotton Stone Mountain near Troy and along Little River to the northeast, pyrophyllite has been known for years. On Cotton Stone Mountain are rather extensive outcrops of fibrous or radiating pyrophyllite. Prospecting has not been done on a sufficiently large scale to indicate how valuable the outcrops may be.

CHATHAM COUNTY

Along Line Creek some two miles northwest of Carbonton and on Indian Creek nearby, prospecting has been done on the farms of David Oldham, C. M. Dowd and Bascomb Andrews. No commercial pyrophyllite has been found, but outcrops of pyrophyllite schist of interest are to be seen.

RANDOLPH COUNTY

About four miles west of Staley, Randolph County, Messrs. Paul and Charlie Gerhardt are developing a very promising deposit of pyrophyllite. The outcrop, which is 750 feet long by 250 feet wide, rises some 100 feet above the surrounding country. This is a very promising deposit.

ORANGE COUNTY

About one mile east of the courthouse at Hillsboro, near where Highway 14 forks from Highway 10, an outcrop of pyrophyllite several feet wide may be seen in the road cut. A few hundred feet to the northeast the pyrophyllite may be seen in the southern bank of the Eno River.

GRANVILLE COUNTY

Beginning about 1½ miles north of Stem and continuing for about one mile in a northeast direction is a zone of pyrophyllite of interest.

Prospecting has been done on a small hill known as Bowling's Mountain, but not on a sufficiently large scale to indicate the size of the deposit. For some distance to the north of this hill crystalline pyrophyllite and pyrophyllite schist outcrops may be seen.

Production

In the early part of 1927 the plant of the United Talc & Crayon Company near Glendon was destroyed by fire. However, before the end of the year, the company had built a larger and more modern plant on the railroad at Glendon. On account of this fire the production of pyrophyllite in 1927 was $15,000 less than that of the previous year. In 1928 the production showed a further decrease. Total figures cannot be shown as only one producer reported a production.

PRODUCERS

PRODUCERS OF TALC, PYROPHYLLITE AND SOAPSTONE IN NORTH CAROLINA IN 1927

Name of Company	Address	Location of Plant	
		Town	County
North Carolina Talc & Mfg. Co.	Hewitts	Hewitts	Swain
Standard Mineral Company, Inc.	Hemp	Hemp	Moore
United Talc & Crayon Company	Glendon	Glendon	Moore
Virginia-Carolina Soapstone Company	Roanoke, Virginia	Jefferson	Ashe

MINERAL PRODUCTION IN NORTH CAROLINA
FROM 1919 TO 1928, INCLUSIVE

YEAR	TOTAL VALUE	YEAR	TOTAL VALUE
1919	$ 6,404,679.	1924	$10,163,437.
1920	8,117,916.	1925	10,699,422.
1921	5,676,301.	1926	11,274,224.
1922	7,483,305.	1927	12,566,882.
1923	11,050,257.	1928	12,355,934.

As shown by the table above the total value of the mineral production in North Carolina has nearly doubled during the past 10 years. This great increase has been confined largely to the non-metallic field, especially clay products, building stone, and feldspar. In the metallic field the production of copper, chiefly from Swain County, has greatly increased during the past three years.

Table showing the quantity and value of minerals and mineral products produced in North Carolina during 1928:

NAME	QUANTITY	VALUE
Brick	300,998,000 brick	$3,157,635.
Tile	62,319 tons	629,408.
Cement Products—(Estimated)	--------	650,000.
Clay—(Kaolin)	19,898 tons	298,951.
Coal	60,860 tons	201,000.
Copper	8,207,000 pounds	--------
Feldspar	105,560 tons	630,042.
Gold and Silver	19,165.46 ounces	13,511.
Granite	1,901,100 tons	4,416,518.
Limestone, etc.	236,680 tons	342,786.
Mica, Sheet	777,395 pounds	129,706.
Mica, Scrap	4,419 tons	69,638.
Pottery	--------	41,450.
Sand & Gravel	971,746 tons	531,092.
Miscellaneous*	----------	1,244,197.
TOTAL	--------	$12,355,934.

*Copper, Talc, Millstones, Etc.

MINERAL PRODUCTION IN NORTH CAROLINA
FROM 1924 TO 1928, INCLUSIVE

MINERAL	1924	1925	1926	1927	1928
Brick and Tile	$4,000,431.	$4,170,445.	$4,225,653.	$3,834,494.	$3,787,043.
Clay (Kaolin)	277,326.	319,599.	331,487.	327,688.	298,951.
Cement Products	500,000.	529,818.	--------	671,242.	650,000.
Coal	224,000.	283,000.	243,000.	191,283.	201,000.
Copper	--------	--------	178,416.	*--------	*--------
Feldspar	640,403.	496,563.	602,020.	612,214.	630,042.
Gold and Silver	--------	18,615.	1,644.	1,018.	13,511.
Granite	3,001,615.	2,865,040.	3,802,017.	4,562,879.	4,416,518.
Iron	32,512.	49,511.	33,045.	81,753.	--------
Limestone Marble, Etc.	336,590.	825,486.	338,811.	477,316.	342,786.
Mica	167,276.	180,198.	204,410.	114,514.	199,344.
Pottery	*--------	*--------	31,248.	27,692.	41,450.
Sand and Gravel	889,050.	886,351.	968,021.	871,416.	531,092.
Talc, Pyrophyllite, Etc.	81,290.	48,550.	97,004.	*--------	--------
Miscellaneous	12,944.	26,246.	217,448.	793,373.	1,244,197.
TOTAL	$10,163,437.	$10,699,422.	$11,274,224.	$12,566,882.	$12,355,934.

* Less than three producers. Figures not available.

As is seen from the above table, the total value of 1927, $12,566,882, is 11.5% greater than the total value of $11,274,224 in 1926. The total value of production in 1928 was less than that of 1927, due principally to the decrease in the production of building materials as brick and tile, granite, and sand and gravel. A great many of the other materials showed an increase in total value, especially copper, feldspar, gold and silver, and pottery. The production of these minerals and products will probably show a greater increase in the year 1929.

APPENDIX I

Alamance	Brick
Alexander	Granite, Hiddenite
Alleghany	Manganese, Iron
Anson	Sand and Gravel, Quartz
Ashe	Iron Ore, Soapstone, Serpentine
Avery	Feldspar, Iron Ore, Mica
Beaufort	
Bertie	Brick
Bladen	Clay
Brunswick	
Buncombe	Granite, Pottery, Sand and Gravel, Feldspar, Kyanite
Burke	Brick and Tile, Gold
Cabarrus	Brick and Tile, Gold
Caldwell	Brick and Tile, Rutile
Camden	
Carteret	
Caswell	Granite
Catawba	Pottery, Sand and Gravel, Mica
Chatham	Brick and Tile, Coal, Copper
Cherokee	Iron Ore, Manganese, Marble, Talc, Quartzite
Chowan	
Clay	Clay, Corundum, Spinel, Garnet
Cleveland	Brick and Tile, Mica
Columbus	Brick and Tile
Craven	Brick and Tile, Limestone and Marl, Sand and Gravel
Cumberland	Brick and Tile, Sand and Gravel
Currituck	
Dare	
Davidson	Brick and Tile, Granite
Davie	
Duplin	
Durham	Brick and Tile, Granite, Quartzite
Edgecombe	
Forsyth	Brick and Tile, Granite, Sand and Gravel
Franklin	Gold
Gaston	Brick and Tile
Gates	
Granville	
Graham	
Greene	
Guilford	Brick and Tile, Pottery, Copper, Gold
Halifax	Brick and Tile, Gold
Harnett	Brick and Tile, Sand and Gravel

Haywood	Feldspar, Mica, Kaolin, Lead
Henderson	Brick and Tile, Granite, Limestone, Sand and Gravel
Hertford	
Hoke	
Hyde	
Iredell	Brick and Tile
Jackson	Corundum, Kaolin, Feldspar, Granite, Mica, Garnet
Johnston	Brick and Tile
Jones	
Lee	Brick and Tile, Coal
Lenoir	Brick and Tile, Clay
Lincoln	Clay, Tin
McDowell	
Macon	Mica, Kaolin
Madison	Limestone, Talc
Martin	
Mecklenburg	Granite, Sand and Gravel
Mitchell	Feldspar, Kaolin, Mica, Quartz, Gems
Montgomery	Brick and Tile, Pottery, Sand and Gravel
Moore	Sand and Gravel, Pyrophyllite
Nash	Brick and Tile
New Hanover	Limestone
Northampton	Sand and Gravel
Onslow	
Orange	Brick, Granite
Pamlico	
Pasquotank	Brick
Pender	Brick
Perquimans	
Person	
Pitt	Brick
Polk	
Randolph	Brick, Gold
Richmond	
Robeson	Brick
Rockingham	Brick, Granite
Rowan	Brick and Tile, Granite, Millstones
Rutherford	Brick, Sand and Gravel, Granite
Sampson	Brick, Sand and Gravel
Scotland	Sand and Gravel
Stanly	Brick and Tile
Stokes	Brick
Surry	Brick and Tile, Granite, Gold
Swain	Copper, Limestone, Talc
Transylvania	Manganese
Tyrrell	

Union	Brick and Tile, Gold
Vance	Granite
Wake	Granite
Warren	Gold
Washington	Brick and Tile
Watauga	
Wayne	Brick and Tile
Wilkes	Brick and Tile, Pottery
Wilson	Granite
Yadkin	
Yancey	Feldspar, Kaolin, Mica, Gems

APPENDIX II

POSSIBILITIES OF PETROLEUM IN NORTH CAROLINA

During the past few years much speculation has been indulged in as to the possibility of obtaining oil and gas in commercial quantities in the rocks of Triassic age and in the formations of the Coastal Plain deposits of North Carolina. In 1924 and 1925 an oil prospecting well was drilled to a depth of 2,351 feet near Havelock, Craven County. The basement rocks, composed of crystalline gneisses and shists, were encountered at a depth of 2,318 feet. The log of this well was kept by Wendell C. Mansfield of the United States Geological Survey and the report published as Economic Paper No. 58 of the publications of the North Carolina Department of Conservation and Development. This report states that "Mr. W. H. Butt's field notebook contains the following statements: 'While trying to set 12½-inch casing at 336 feet, Mr. Orr (contractor) states there was a small show of gas. Gas show began around 720 to 725 feet.' No show of oil is recorded at any depth in Mr. Butt's notes."

In 1927 another oil prospecting well was started near Clinton in Sampson County. The well was drilled to a depth of something like 600 feet and was abandoned. From newspaper reports received at the office of the State Geologist, several of the members of the company doing the drilling were arrested for making whiskey. Soon after this report came out the well was abandoned and nothing has been done further about completing the well.

Since these two wells have been abandoned several other attempts have been made to organize companies to drill for oil and gas but none have been successful. Several possible locations have been pointed out by "so-called" oil geologists, among these the most important are Shallotte Inlet in Brunswick County; near Greenville in Pitt County; a few miles west of Albemarle in Stanly County; near Greensboro in Guilford County; between Shelby and Gastonia in Cleveland and Gaston Counties; in the Dan River area of Stokes and Rockingham

Counties; and in the Deep River section of the Triassic basin of Lee County.

"In conducting the geologic study of the possibility of oil pools, there are four elements that enter into the problem. These are: (1) the presence of rock of such a character that they may have served as the place of origin or source of oil or gas; (2) porous sandstones or limestones into which the oil, when formed, can collect; (3) a geologic structure or fold of such a character that it will trap the oil and gas as they migrate through the porous rock; and (4) a non-porous shale or clay above the sandstone to seal in its oily contents and prevent their escape."*

(1) Since petroleum is derived largely, if not wholly, from organic remains, it is necessary to find a fairly thick stratum which contains fossil remains in abundance. The presence of coal beds in the Deep and Dan River areas and the peat beds in the Coastal Plain formations are indications of abundant vegetable growth, but the overlying materials are so coarse, except in the Cumnock formation in the Deep River area, that air could have reached the enclosed vegetal growth and caused its destruction. In the Cumnock formation there is not enough vegetal material to have supplied a very large amount of oil. Then, too, a great deal of faulting has occurred and a great many igneous dikes have cut the formation which would have caused the escape of the oil or gas. In view of the above facts the most promising location would be between Cumnock and Gulf where the formation is thickest and where the least disturbance has occurred.

(2) In the Deep and Dan River areas of the State there are beds of porous sandstone which would serve as reservoirs if all other conditions were favorable to the accumulation. In the Coastal Plain formations these conditions are quite different. Most of the formations of this area are unconsolidated, hence if oil or gas ever existed they would have escaped long before now. Dr. Collier Cobb, head of the Department of Geology at the University of North Carolina, states that there is no geological evidence of oil in the Coastal Plain formations.

* Bulletin No. 33, N. C. Geol. and Eco. Survey, Raleigh.

(3) The experience of well-trained geologists all over the world has demonstrated that 90% of the oil is found in anticlines or arches in the sedimentary rocks, hence the first thing a geologist does is to look for such structures. Campbell and Kimball state in Bulletin No. 33 of the publications of the North Carolina Department of Conservation and Development that "in general the rocks of the Deep River area have been depressed into troughs or basins rather than raised into anticlines or arches. Thus the Carthage and the Corinth troughs are both essentially synclinal in structure, although in each case the syncline is not complete because of the great fault along the southeast side. On account of this structure neither basin nor trough can be considered a favorable place to drill for oil." In the Coastal Plain formations no well defined arches or anticlines occur. These formations are monoclines dipping toward the ocean in a southeast direction.

(4) The different beds of the formations in the sedimentary rocks of the State are not well enough known to say positively that any given porous sandstones are overlain with non-porous shales, but generally the succession of shale and sandstone is the rule and it is probable that most porous sandstones have a shale cap. This element of the problem may be taken as favorable but the other elements are unfavorable.

Other than the Deep and Dan River areas of Triassic age and the Coastal Plain formations from Cretaceous to present in age all the formations of the State are composed of metamorphic rocks. Metamorphic rocks are rocks which have undergone a change induced by crustal movements probably accompanied by the development of sensible heat. No trained geologist would consider for a moment the possibility of such rocks containing oil or gas. As to the sedimentary rocks outlined above, no one can say positively that oil does not occur in these rocks but they can say that all of the facts obtained so far are of the negative character and that in their opinion it is not worth spending time or money in prospecting where conditions appear to be so unfavorable.

POPULAR FALLACIES WITH REGARD TO OIL

During the past year many fallacious ideas regarding the occurrence of oil and gas have come to the attention of the State Geologist. Some of the ideas are absolutely absurd to anyone with the average intelligence. Some of the ridiculous ideas outlined below were taken from the "Seventeenth Annual Report" of the Florida State Geological Survey by Herman Gunter. These are true in North Carolina as well as in Florida.

"WIGGLE STICKS"

Many of the so-called trained oil geologists claim to be able to locate oil pools by means of a forked stick. The stick is placed in the hands of one "who knows how" to use it. As soon as a "pool" is located, the prong of the stick will "by its own magnetism" point toward the ground. It is said that this same method has been used many times to locate wells for water. It is claimed by the users that the stick must be in the hands of an "expert" or it will not work.

On one occasion a call came to the office of this Department that a large oil pool had been located in Brunswick County near Shallotte Inlet so the writer made a trip to that section of the county. After some little argument, he persuaded the "oil expert" to explain how he knew oil occurred there. The "expert" stated that he not only knew that oil occurred but he knew exactly how much. He said he knew this because he had sent his "spirit" down into the ground to find out for him. This same man is still in the State and expects to get the necessary funds with which to drill the well.

GAS BLOW-OUTS

Many of the so-called "oil experts" attempt to prove that oil and gas occur in certain localities by the fact that "gas blow-outs" have occurred in the past "geological times." Usually some isolated pile of rocks is so termed and accounted for by the internal expansion of gas. Such piles of rock are found in North Carolina especially along the upper Coastal Plain area. These fragments of rock are nothing more than the remnants of formation that were more resistent to weather-

ing than others and are due to normal erosion action. An outcrop of the gneissic granite between Clayton and Smithfield has been brought to my attention as being one of the best examples of a "gas blow-out" in the State.

Another very popular type of "gas blow-out" is the lime sink found in the lower Coastal Plain section underlain with marl, shell-rock and limestone. These sinks are more or less circular in outline and are often pointed out as evidence of the near surface occurrence of natural gas. All of these sinks of course are formed by underground solution which causes the roof of some subterranean cavern to fall in. These sinks occur over a wide area in the central and south-central part of Brunswick County.

TOPOGRAPHY

Many of the "oil experts" who are more or less familiar with certain of the oil fields argue that the surface of the Coastal Plain is similar to the oil lands of Louisiana and Texas and, therefore, must contain oil in commercial quantities. The "look" of the surface as soil and vegetation has nothing whatsoever to do with the question of the sub-surface structure and the accumulation of oil. In certain sections of Pitt and Sampson Counties round-topped ridges and hills are called "domes" or "highs" which have been uplifted by gas pressure. These so-called "domes" or "highs" are nothing more than erosional ridges or hills which withstood the processes of erosion better than the surrounding materials. In the Triassic basins of the Deep and Dan River sections the ridges caused by diabase dikes are often pointed out as "oil domes." This is also true of granitic outliers occurring near the edges of these basins, especially those on the western side of the Deep River area. These ridges and dome-like masses are due to the more resistent rocks composing them.

VEGETATION

Another line of argument used by the "oil expert" is the type of vegetation occurring in that particular locality. The vegetation of a locality depends on the soil, climate and rainfall and not on the types of formations which may occur several

hundred feet below the surface. In many instances the vegetation is an aid in tracing certain formations but it is not a direct indication of oil.

OIL SCUM

In regions where there is an abundance of ferruginous material in the soil there is often an iridescent scum which forms on the water. This scum is called an oil scum and is a "sure indication of oil." The simplest way of testing this scum is to break it up with a stick. If it is oil, it will come back together immediately; if iron oxide, it will remain apart in flake-like masses. This iron scum is found only on water which does not flow rapidly. This scum is found especially along slow flowing streams and on ponds, in the Coastal Plain area. However, in certain sections where there is an abundance of decaying organic material, an organic scum is formed which behaves very much like an oil scum. A very simple way to test this is to collect some of the scum, put in a bottle with chloroform or carbon tetrachloride, shake well, filter through a filter paper and slowly evaporate the filtrate. If it is oil a dark ring will be left on the evaporating dish.

OIL MIGRATION

Some of the arguments advanced by the "oil experts" for the occurrence of oil in North Carolina is the "migration theory." Several have admitted that oil has not originated in the State but that a great deal has migrated from other fields, especially from Pennsylvania and West Virginia. Such argument fails to take into consideration the great belt of crystalline rocks which lies between these States and the Coastal Plain area of North Carolina. Neither does oil have such "great migrating powers."

One of these "geologists" tried to explain the origin of the oil in North Carolina by a "great cataclysm" or by "an earth disturbance of cataclysmic proportions" which began in the western part of the State and continued to the coast, which ground or distilled oil from the plants growing on the "intervening terraine." This oil, after being distilled out, collected

in pools in the Coastal Plains sands. This statement is also absurd.

Conclusions: From information thus far received or collected by geologists who are competent to work out structures there is no geologic evidence of oil occurring in commercial quantities in North Carolina. However, many of the citizens of the State have desired to have wells drilled to prove the presence or absence of oil or gas. Wells that have been drilled or that have been proposed in North Carolina have smacked greatly of the promoters' influence. In view of these facts, men of the State desiring to have wells drilled for oil should be careful in selecting competent drillers to do the work.

LIST OF PUBLICATIONS

CONSERVATION AND INDUSTRY, a monthly publication, devoted to information about and discussion relating to the conservation and development of the State's natural resources and their place in the life of the people, is mailed free upon application. Its contents are available, for use in the press or otherwise, with or without credit or acknowledgment.

There have been printed and are on hand for distribution at the prices, noted, a number of publications—bulletins, economic papers, volumes, reports, circulars—covering a wide variety of subjects and special studies, as follows:

MINES AND MINERALS

Bulletin No. 2. Building and Ornamental Stones in North Carolina, by T. L. Watson and F. B. Laney, in collaboration with George P. Merrill, 1906. 8°, 283 pp., 32 pl., 2 figs. *25 cents.*

Bulletin No. 11. Corundum and the Basic Magnesian Rocks of Western North Carolina, by J. Volney Lewis, 1895. 8°, 107 pp., 6 pl. *5 cents.*

Bulletin No. 19. The Tin Deposits of the Carolinas, by Joseph Hyde Pratt and Douglas B. Sterrett, 1905. 8°, 64 pp., 8 figs. *4 cents.*

Bulletin No. 21. The Gold Hill Mining District of North Carolina, by Francis Baker Laney, 1910. 8°, 137 pp., 23 pl., 5 figs. *15 cents.*

Bulletin No. 22. A Report on the Cid Mining District, Davidson County, N. C., by J. E. Pogue, Jr., 1911. 8°, 144 pp., 22 pl., 5 figs. *15 cents.*

Bulletin No. 25. Zircon, Monazite and Other Minerals Used in the Production of Chemical Compounds Employed in the Manufacture of Lighting Apparatus, by Joseph Hyde Pratt, Ph. D., 1916. 8°, 120 pp., 3 pl. *15 cents.*

Bulletin No. 28. Limestones and Marls of North Carolina, by G. F. Loughlin, E. W. Berry, and J. A. Cushman. Prepared by the North Carolina Geological and Economic Survey, in coöperation with the United States Geological Survey, 1921. 8°, 211 pp., 7 pl., 3 figs. *15 cents.*

Bulletin No. 29. The Kaolins of North Carolina, by W. S. Bayley. Prepared in coöperation with the United States Geological Survey. *50 cents.*

Bulletin No. 31. Deposits of Brown Iron Ores (Brown Hematite) in Western North Carolina, by W. S. Bayley. *50 cents.*

Bulletin No. 32. Magnetic Iron Ores of Western North Carolina and Eastern Tennessee, by W. S. Bayley. *15 cents.*

Bulletin No. 33. The Deep River Coal Field of North Carolina, by Marius R. Campbell and Kent K. Kimball. Prepared in coöperation with United States Geological Survey. *10 cents.*

Economic Paper No. 15. The Mining Industry in North Carolina During 1907, by Joseph Hyde Pratt, 1908. 8°, 176 pp., 13 pl., 4 figs. *15 cents.*

Economic Paper No. 23. The Mining Industry in North Carolina During 1908, 1909 and 1910, by Joseph Hyde Pratt and Miss H. M. Berry, 1911. 8°, 134 pp., 1 pl., 27 figs. *10 cents.*

Economic Paper No. 49. The Mining Industry in North Carolina During 1913-1917, inclusive, by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1919. 8°, 170 pp. *20 cents.*

Economic Paper No. 55. The Mineral Industry in North Carolina, 1918-1923, inclusive, by Brent S. Drane, and Jasper L. Stuckey, Geologist, 1925. 8°, 104 pp. *25 cents.*

Economic Paper No. 58. Oil-prospecting Well near Havelock, North Carolina, by Wendell C. Mansfield, of the United States Geological Survey, in coöperation with the North Carolina Geological and Economic Survey, 1927. *5 cents.*

Economic Paper No. 59. Oil-bearing Shales of Deep River Valley, by F. C. Vilbrandt, Ph. D. Prepared in coöperation with the Department of Conservation and Development, 1927. *10 cents.*

Economic Paper No. 60. The Mineral Industry in North Carolina, 1924-1925, by H. J. Bryson, Acting State Geologist, 1927. *15 cents.*

Economic Paper No. 62. The Mining Industry in North Carolina During 1926, by H. J. Bryson, State Geologist, 1928. *Out of print.*

Economic Paper No. 63. The Mining Industry in North Carolina During 1927 and 1928, by H. J. Bryson, State Geologist, 1930. *25 cents.*

GEOLOGY AND PALÆONTOLOGY

Bulletin No. 18. Bibliography of North Carolina Geology, Mineralogy and Geography, with a list of maps, by Francis Baker Laney and Katherine Hill Wood, 1909. *Cloth-bound $1.00.*

Vol I. Corundum and Peridotites in Western North Carolina, by Joseph Hyde Pratt and J. Volney Lewis, 1905. *35 cents.*

Vol III. The Coastal Plain Deposits of North Carolina, by William Bullock Clark, Benjamin L. Miller, L. W. Stephenson, B. L. Johnson and Horatio N. Parker, 1912.

Pt. 1. The Physiography and Geology of the Coastal Plain of North Carolina, by Wm. Bullock Clark, Benjamin L. Miller, and L. W. Stephenson. *25 cents.*

Pt. 2. The Water Resources of the Coastal Plain of North Carolina, by L. W. Stephenson, and B. L. Johnson. *25 cents.*

Vol V. The Cretaceous Formations of North Carolina, 1923. *50 cents.*

Pt. 1. Invertebrates of the Upper Cretaceous Formations, by Lloyd William Stephenson.

Educational Series No. 1. The Story of the Geologic Making of North Carolina, by H. J. Bryson, State Geologist, 1928.

GEOLOGY AND TOPOGRAPHY

Map of North Carolina; scale 1-500,000; unmounted. *75 cents.*

Map of North Carolina; scale 1-500,000; mounted on cloth. *$1.50.*

Map of Beaufort County; scale 1-40,000; colored paper. *25 cents.*

Map of Franklin County; scale 1-40,000; colored paper. *25 cents.*

Map of Surry County; blue and white paper. *25 cents.*

Map of Virgilina District; colored paper; geological. *25 cents.*

Bulletin No. 27. The Altitudes of North Carolina, 1917. *20 cents.*

EXAMINATION OF MINERAL SPECIMENS

Samples of any mineral found in the State may be sent to the Department of Conservation and Development, Raleigh, N. C., for identification, and the same will be classified free of charge. It must be understood, however, that NO ASSAYS OR QUANTITATIVE DETERMINATION WILL BE MADE. Samples should be in lump form, if possible, and marked plainly on outside of package with name of sender, post office address, etc; a *letter* should accompany sample and *stamp* should be enclosed for reply.

NORTH CAROLINA
DEPARTMENT OF CONSERVATION AND DEVELOPMENT
R. BRUCE ETHERIDGE, *Director*

ECONOMIC PAPER NUMBER 64

THE MINING INDUSTRY
IN
NORTH CAROLINA FROM
1929 to 1936

BY

HERMAN J. BRYSON
State Geologist

RALEIGH
1937

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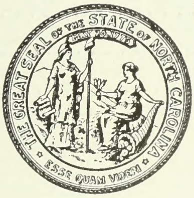

RALEIGH
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LETTER OF TRANSMITTAL

RALEIGH, N. C., December 1, 1936.

To his Excellency, HON. J. C. B. EHRINGHAUS
Governor of North Carolina

SIR:—I have the honor to submit herewith, as Economic Paper No. 64, a review of the Mining Industry in North Carolina for the years 1929 to 1936, inclusive. In this report are taken up the statistics of production of the various minerals that were mined in the State during this period. This report describes briefly some of the new developments within the State. It also gives maps showing the location of the mineral deposits as well as the location of plants. This period has been a most important one in the history of the industry in North Carolina.

Very respectfully,

R. BRUCE ETHERIDGE,
Director.

FOREWORD

The present report, entitled the "Mining Industry in North Carolina from 1929 to 1936, Inclusive," attempts to outline briefly the status of the mining industry of this State during that period. The statistics of production published have been collected by the Division of Mineral Resources of the Department of Conservation and Development with the cooperation of the United States Geological Survey and the United States Bureau of the Census, and, in some cases, the general status of each industry has been verified by a personal investigation.

There have been included short reports on "Kyanite" by Dr. J. L. Stuckey, Professor of Geology, North Carolina State College, Raleigh, N. C., and "Spodumene" by Frank L. Hess, United States Bureau of Mines, Washington, D. C. Permission was given by these men to publish the reports.

Maps are included to show the location of the economic mineral deposits, as well as the active mineral plants producing minerals from the various deposits. The maps have not heretofore been published.

HERMAN J. BRYSON,
State Geologist.

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FIGURE 1. GRAPH SHOWING TREND OF MINERAL INDUSTRY IN NORTH CAROLINA FROM 1926 TO 1935

THE MINING INDUSTRY IN NORTH CAROLINA FROM 1929 TO 1935, INCLUSIVE

By HERMAN J. BRYSON
State Geologist

INTRODUCTION

From the year 1929 to 1935, the mining and quarrying industries in North Carolina followed more or less the trend of the business conditions in the United States. The maximum value of production of minerals in the State was reached in 1929, and showed a total value of $14,668,817. The production declined steadily until 1932, when the total value was $3,794,999. However, in 1933 the production was somewhat larger than that for 1932, and the total value of production has increased steadily since that year.

From 1933 to 1935 several new plants have been constructed and many old plants reopened or rebuilt during that period. Especially has this been true of the gold mining industry. There has probably been as much money invested in gold mining, in prospecting, in development, and in plant construction, in 1934 and 1935 as has been expended in any like period in the history of the State. Probably the outstanding development in the gold mining industry has been the construction of flotation plants, which heretofore have not been built to handle the ores occurring in the State.

During the past seven-year period, there have been erected ten gold recovery plants, most of which were small stamp mills from five to forty tons capacity per day. However, three flotation mills were erected, and are apparently proving successful, as they have been in operation for some time.

In addition to those plants already erected, others are contemplated for the near future.

Probably the next outstanding development in the mineral industry in North Carolina is in the kaolin clay industry in

Yancey, Mitchell, and Avery counties. In the early part of 1936, two large plants were under construction which will produce in the beginning from fifty to sixty tons of clay and from thirty to forty tons of scrap and punch mica per day. It is estimated that the total cost of the purchase of the properties, exploration and development work, and the construction of the plants will be more than half a million dollars.

During the past two years, considerable investigations have been made on the vermiculite deposits. One plant and a large laboratory have been constructed as a result of the investigations so far conducted.

On account of the decrease in the building industry from 1929 to 1932, the stone production and the heavy clay products, as brick, tile and like materials, decreased considerably. However, with an increase in construction during 1933 to 1935, the production of the above materials has increased considerably.

On account of the new uses for talc and pyrophyllite during the depression years, these minerals have shown a substantial gain in total value of production, greater than during any like period in the history of the State.

Another outstanding development which may be classed in the mineral field was the construction of a four million dollar bromine recovery plant southeast of Wilmington. It is estimated that the total value of the products produced annually exceeds one million dollars. However, if all of the materials contained in the sea water passing through the plant were recovered, the total value of production would be exceedingly high. Bromine is the new element used in the manufacture of high-test gasolines.

The following may be mentioned as favorable opportunities for the investment of capital in the mineral resources and mineral products manufactured from them in North Carolina:

Development and operation of low-grade gold deposits.

Development of lithium (spodumene) deposits in Gaston County.

Further development in the pyrophyllite deposits of the Piedmont section.

Plants for the manufacture of wall board from vermiculite and low-grade asbestos for heat and sound insulation.

Pottery plants for utilizing the kaolin, feldspar, and quartz produced in western North Carolina. The erection of additional kaolin recovery plants.

Glass plants for the manufacture of bottles and baking dishes.

The construction of plants for the manufacture of light-weight brick for insulation purposes.

Development and operation of coal deposits in the Deep River section.

Below is given the table showing the total value of mineral production in North Carolina from 1929 to 1935, inclusive:

MINERAL PRODUCTION IN NORTH CAROLINA

FROM 1929 TO 1935, INCLUSIVE

Products	1929	1930	1931	1932	1933	1934	1935
Brick and Tile	$ 3,139,723	$1,673,773	$1,113,961	$ 538,721	$1,002,265	$1,100,685	$1,200,000
Bromine						*	*
Cement Products							
Clay (Kaolin)	282,782	391,571	195,700	202,528	102,814	106,742	119,272
Coal	177,000	100,000	*	*	*	*	*
Copper	*	*	*	*	*	*	*
Feldspar							
Crude	598,938	593,552	505,525	300,877	471,312	465,214	482,729
Ground	1,236,206	1,012,915	761,080	614,936	707,667	847,835	1,043,979
Gold and Silver	11,283	22,963	12,956	6,847	13,463	24,056	85,114
Granite	5,344,032	3,473,406	3,607,966	1,323,780	1,631,464	1,706,570	1,422,174
Limestone, Marble	277,846	244,038	98,956	128,172	305,029	134,026	120,418
Mica							
Sheet	150,293	112,451	51,657	18,322	21,107	38,674	77,598
Scrap	53,855	75,400	5,312	4,837	6,918	47,246	153,553
Pottery							
Quartz	28,709	23,835	11,460	*	65,483	*	*
Sand and Gravel	1,020,533	437,555	238,053	99,640	201,113	225,588	310,291
Talc	81,306	105,000	170,250	202,229	135,523	165,523	220,074
Undistributed	2,266,411	1,820,000	808,508	354,110	579,000	1,982,312	2,267,360
Total	$14,668,817	$10,086,459	$7,581,384	$3,794,999	$5,243,158	$6,754,471	$7,502,567

As is shown by the above table, the mineral industry is on the up grade, largely because of the revival of business throughout the country. However, some of the increase may be due to new uses for North Carolina crude minerals as well as to some extent to the new methods of recovery and beneficiation of the various minerals.

There is given in the following pages a discussion of the minerals and mineral products that have been investigated, mined, or produced in North Carolina during the years 1929 to 1935, inclusive. These minerals may be classed into two chief groups: metallic and nonmetallic. The most important investigations in the metallic mineral field were for gold, silver, chromite, copper, ilmenite and rutile, lead-zinc, manganese, nickel, and tin. In the nonmetallic field they will be discussed in the following order: abrasive materials, as asbestos, barite, clays, coal, kyanite, feldspar, mica, quartz, sand and gravel, stone, talc, and pyrophyllite; and the miscellaneous group, as zircon, monazite, volcanic ash, spinel, olivine, beryl, and spodumene.

METALLIC MINERALS

GOLD AND SILVER

From 1929 to 1932 there was very little activity in the gold and silver industry in North Carolina. However, with the increase in the price of gold from $20.67 to $35.00 per ounce during the years 1933 and 1934, there has been considerable activity in the gold mining industry.

During the above period probably the outstanding development in the gold mining industry was the construction of flotation plants which heretofore had not been constructed within the State. The first plant constructed was on Rocky River, in the southeastern corner of Cabarrus County. This plant was erected to handle ores from mines owned by the Cabarrus Mining and Milling Corporation but was later used to mill ores from mines not owned by the company. This plant has operated intermittently for two years. Mass flotation is the practice, but selective flotation was attempted but did not prove successful.

The principal owners of the Cabarrus Mining and Milling Corporation, of Charlotte, have reopened the old Rudisil Mine, which had quite an interesting history. Soon after the mine was put into operation, the second flotation mill was built by the Rudisil Mining Company, two miles south of the City of Charlotte. This plant was erected to handle the ores from the Rudisil Mine.

With the success of the flotation mill at the Rudisil Mine, another company was organized by the same group, known as

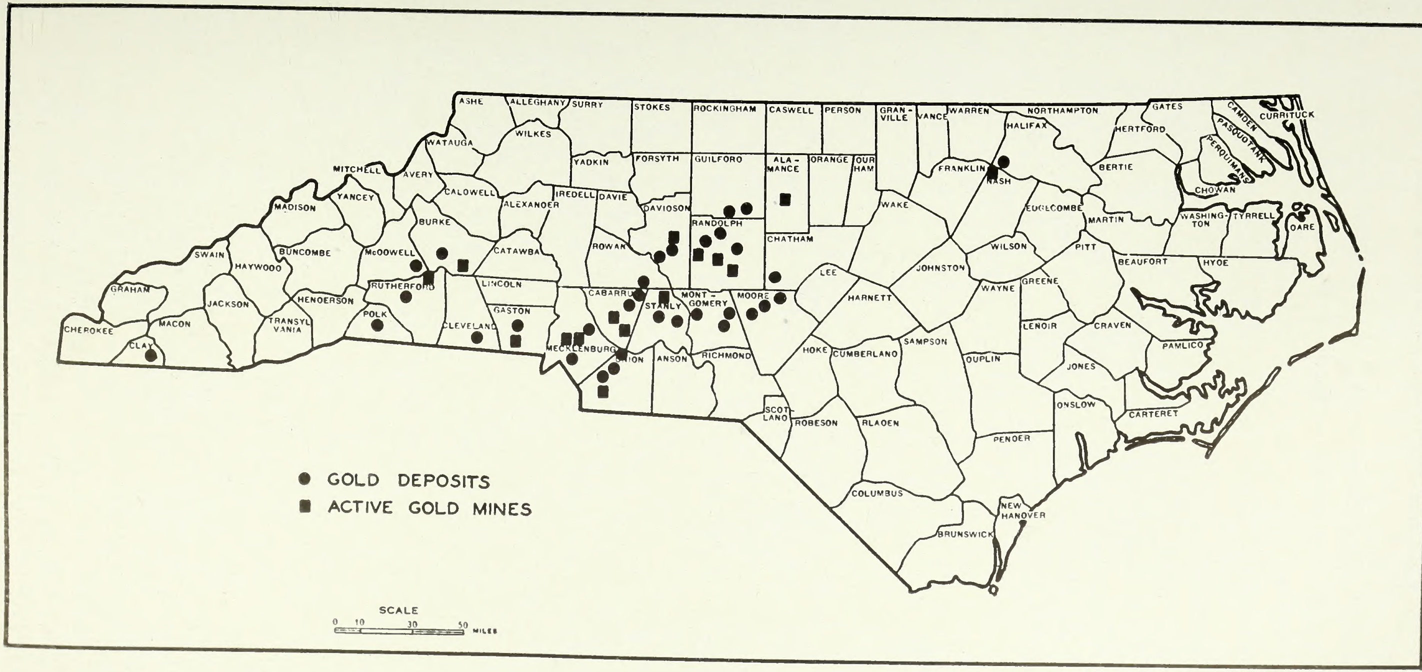


FIGURE 2. MAP SHOWING LOCATION OF GOLD DEPOSITS AND PLANTS ACTIVE DURING PERIOD FROM 1929 TO 1935

the Keystone Mining Company, which erected the third flotation plant at the Keystone Mine located in the eastern section of Randolph County. This plant was in full operation since its construction until it closed in January, 1937.

The production of gold and silver in 1932 was only $6,847, while that in 1935 reached $85,114. Most of this production came from the Rudisil Mine, operating within the limits of Charlotte. The remainder of the production came from small stamp mills and from placer operations located principally in the Piedmont section. Some gold and silver was produced as a by-product from the copper mines in Jackson and Swain counties.

There is given a brief resumé, by counties, of the gold and silver mining industries in the State.

Burke and Rutherford counties: In the *South Mountain district,* especially in Burke and Rutherford counties, considerable exploration and development work has been accomplished. Probably the outstanding development conducted in these counties was on the headwaters of Silver Creek, on the Mills property at Burningtown. These placer deposits cover a large area on both sides of Silver Creek, and include other properties on the east side of Pilot Mountain. Most of this area has been worked from time to time in the past—since its discovery in 1829—but there still remains considerable area which may be considered as virgin ground. Also, a great deal of the tailings left from previous mining operations will probably pay to rewash. However, one thing which has handicapped this area for more extensive mining operations has been the lack of sufficient water for mining purposes and the clayey nature of the placers.

The valley was first drilled by Mr. H. D. McDonald, of the U. S. Smelting, Mining, and Refining Company, and later by Mr. F. C. Fearing, for New York interests. However, both companies turned down the properties, not so much on account of the low value as because of the difficulty in handling the clayey materials and lack of sufficient water.

Little information is available as to the total value of the area prospected. The value per cubic yard is variously estimated from 12c to 80c. However, it is believed that the average value per cubic yard will not exceed 25c. Therefore, on account of the

high clay content of the placer material, it is doubtful whether profit can be made on material which does not exceed 25c per cubic yard.

Between Rutherfordton, in Rutherford County, and Dysartville, in McDowell County, in the vicinity of Union Mills, considerable prospecting has been done to determine the extent and value of the quartz veins. At one location Mr. D. L. Ward, of Rutherfordton, has located a quartz vein that has shown consistently high values, in some instances over $100 per ton. Because of the lack of capital, however, Mr. Ward has not developed the property to determine fully the extent of the vein. A shaft has been sunk to a depth of approximately 90 feet, and the vein exposed was from 2 to 3 feet in width, showing considerable sulphides at depth, while near the surface the ore was "honeycombed" because of the oxidation of the sulphides. A small stamp mill was erected to mill the ore. The free gold is caught on amalgamation plates, while the sulphides are recovered on a concentration table.

Mr. E. B. Ward, Asheville, North Carolina, sank a shaft on a quartz vein near *Union Mills.* The quartz vein, however, at a depth of 75 feet pinched to about 4 to 6 inches in width, with gradual decrease in value. At the bottom of the shaft a drift was sent out approximately 100 feet, but the vein did not show increased width.

In the extreme eastern edge of Burke County, the old *Hercules Mine* shaft was cleaned out and sunk to a depth of 110 feet. At this depth a very rich pocket of gold was encountered. It is reported that a flour sack full of ore yielded $1,500 in gold. Additional prospecting was accomplished but no other rich bodies of ore were encountered. The owners reported the sale of the property to Tennessee interests, but to date the property has not been developed further.

Cherokee County: During the past three or four years, a great deal of prospecting was done for both placer and vein deposits along the valley of Valley River, but to date nothing of importance has been uncovered. Some very coarse gold can be panned at a number of places along the river, but it seems to be of indefinite quantity. It is not likely that any commercial deposits of gold will be discovered in this county.

Clay County: In Clay County, near Warne, some prospecting has been done on a quartz vein. Mr. M. R. Hilford, Hendersonville, was in charge of the prospecting and development work. Mr. Hilford said that a good quartz vein was uncovered which showed fair values. A small stamp mill was shipped to the property but was never erected on account of litigation.

Gaston County: At several localities in Gaston County, some exploration and development work was done to determine the extent and value of the quartz veins. The only deposit which revealed anything of value was the *Ferguson Mine.* This property was purchased by Mr. W. M. Fulton, of Knoxville, Tennessee. A small flotation mill has been erected at another property owned by Mr. Fulton, and the ore from the *Ferguson Mine* will be shipped to the mill located in South Carolina.

Mecklenburg County: The most important gold mining development within the State during the past few years is at the *Rudisil Mine* within the southern limits of the City of Charlotte. The mine was unwatered to a depth of 250 feet, and further prospecting and development work completed. The ore uncovered was in such quantity and quality that a flotation mill was erected. The mine has been in continuous operation since May, 1935. The work was retarded for several months on account of law suits, but since the company won the suits, plans are now underway for considerable development work. The possibility for commercial production at this mine is quite favorable, and in all probability will be in operation for several years.

The *Capps Mining and Milling Corporation,* under the direc- of Hugh Jardine, of Toronto, Canada, has taken over the old *Capps* property located eight miles west of Charlotte. The exploration and development work so far conducted has proved quite satisfactory, and plans are underway for the erection of a recovery plant. This mine apparently has considerable potential value.

In addition to the above developments in Mecklenburg County, further prospecting has been accomplished at the McCall and Dunn mines, and at several prospects in and near the City of Charlotte.

Cabarrus County: In Cabarrus County several old mines have been unwatered, and considerable prospecting and development work carried on. Probably the most important work so far

accomplished is at the *Allen Furr* or *Midas Mine,* by the Midas Mining Company, of Winston-Salem. The shaft has been sunk to a depth of 110 feet, and 200 or 300 feet of drift work have been completed. The ore produced at this mine was shipped to the flotation mill on Rocky River.

Some development work was accomplished at the *Snyder Mine* in the southeastern part of Cabarrus County. A shaft was sunk to a depth of 137 feet by Mr. E. L. Hertzog, of Spartanburg, South Carolina, for officials of the American Smelting and Refining Company. Since the vein seemed to pinch and the values to decrease with depth, development work stopped. However, since that time, Mr. A. L. Nash, Salisbury, North Carolina, has taken over the property, erected a small ten-stamp mill, and has treated most of the ore from the dump. The shaft is to be unwatered, and it is planned to do drift work.

On the same mining tract as the Snyder Mine, the *Faggart Mine* shaft was cleaned out and some drift work done. The vein showed only about 18 inches in width, but values up to $40 per ton. Mr. Nash plans to mill the ore from the Snyder and Faggart mines at the stamp mill erected at the Snyder Mine. The free gold is caught on amalgamation plates, and the concentrates saved on the concentration table.

The old *Whitney* group of mines, including the Whitney, Isenhour, and other mines, was unwatered to a depth of approximately 300 feet, and further sampling was undertaken by the Clericy Mining Company, of Toronto. Mr. C. A. Heberlein, of New York, was in charge of the development work in the beginning, but later he was succeeded by Mr. J. P. Sloss, of Missouri. Some very interesting ore was encountered, but apparently the engineers did not think it to be of commercial value, as the work was soon abandoned.

At the *Stallings Mine,* near Georgeville, Furr and Smith sank three shafts on a quartz and slate vein. The mineralized portion of the vein is about 20 inches in width and is apparently the west extension of the Phoenix vein. Near the surface the ore is free-milling, but at depth sulphides are encountered.

The *Cruse Copper Mine,* or *Cline Gold Mine,* four miles south of Mt. Pleasant, was unwatered. The shaft is 240 feet in depth. At the bottom, drifts extend 10 feet to the north and 15 feet to the south. The vein is 30 inches in width, very highly mineral-

ized and shows considerable chalcopyrite. Gold values range from $2 to $105 per ton, with an average of about $38. It also carries about 7 per cent copper.

In addition to the above developments, several other properties, as the Eva Furr, Harkey, 813, Buffalo, and Rocky River mines were dewatered and considerable exploration and development work completed. The work, however, at all of these mines has been discontinued.

Union County: The most important development work in Union County was accomplished by the Condor Consolidated Mines, Ltd., of Toronto, Canada, at the *Howie Mine.* The mine was unwatered, core-drilled, and sampled carefully. A very large deposit of commercial ore was blocked out, but on account of some misunderstanding among the owners, a mill has not been erected. However, the plans of the company are to erect a 100-ton cyanide mill. This mine has considerable merit, and will probably develop into a good gold producer.

At the *Rogers* property, ten miles southwest of Waxhaw, J. L. Yountz, of Indian Trail, erected a five-stamp mill and milled a great deal of surface quartz. In the prospecting work a 4 to 6 inch quartz vein was encountered which was very rich. An incline shaft was sunk on the vein to a depth of approximately 60 feet. The vein did not increase in width at depth as was expected, neither did the high values continue; so the mill only operated about four months.

At the *Moore Mine,* five miles southeast of Indian Trail, Mr. A. J. Terry, of Charlotte, reconditioned an old Lane mill to handle the ore from this property. The gold occurs in a very soft decomposed schist, is very fine, and therefore hard to recover. However, the mill is still in operation.

Several other mines, as Phifer, Black, Lemmond, and Davis, were unwatered and some development work done.

Davidson County: Probably the most important development in Davidson County is that accomplished by Mr. E. W. Stevens, near Cid, at the *Lytton* and *Empire Mines.* Mr. Stevens has spent approximately $100,000 in working out a process to recover the gold from the upper soft decomposed rock or saprolite. A small cyanide plant has been erected to handle the ore. Mr. Stevens reports that he has made satisfactory progress, and that most of the machinery used was designed by him.

At the *Conrad Hill Mine,* Mr. B. A. C. Craig, of Toronto, has retimbered the shaft to water level, and plans to dewater the mine and to do further prospecting and development work. Mr. Craig is a Canadian Geologist with considerable experience in pre-Cambrian formations, therefore should be of great help in working out the geology of the pre-Cambrian formations of the Piedmont section. He seems to be quite well pleased with the geology of the Conrad Hill section, and plans to thoroughly prospect and sample the Conrad Hill Mine.

Mr. H. D. McDonald, of the U. S. Smelting, Mining, and Refining Company, unwatered the *Peters Mine* and did some exploration work, such as retimbering the old shaft, crosscutting, and sampling. Nothing of any value was encountered, so the work did not continue very long.

Other mines in this county which have been prospected to some extent are the Liberty and Ward.

Stanly County: In Stanly County some development work was done at the Thompson, Herne, Parker, Crowell, Haithcock, Mumford and Ingram mines.

At the *Thompson Mine,* in the extreme eastern part of Stanly County, seven miles east of Albemarle, Mr. Ed Snuggs, of Albemarle, erected a small 10-stamp mill. Soon after the erection of the stamp mill the engineer in charge was killed in an automobile accident, and the property was then leased to Mr. C. W. Wheelock, of New York.

The ore at the Thompson Mine consists of the slates of volcanic origin, which dip at a steep angle to the west and strike in a northeast-southwest direction. On the east side of the deposit a brecciated volcanic tuff is exposed. The slates are much fractured and broken, and along these fracture planes, a great deal of pyrite is found which carries gold. Also, small pyrite cubes are found in the slate, which carry gold.

Under the direction of Mr. Wheelock, several drill holes were sunk on the west side of the deposit to encounter the ore at depth. However, it is believed that all of the holes except two were not of sufficient depth to encounter the gold-bearing zone. One hole 20 feet to the west side of the pit encountered sulphides from the 15-foot level to 106 feet. Analyses made at Badin showed that the ore averaged about $4 per ton the entire depth. Near the eastern side of the pit, which is approximately 150 feet

in length and 50 to 60 feet in width, there is exposed about 6 or 8 feet of soft decomposed ore that pans exceptionally well. Also, near the bottom of the pit on the west side, there is found some very high-grade ore, which showed assays up to $50 or $60 per ton.

The stamp mill which was erected on the property recovers approximately 30 to 40 per cent of the gold values. Assays of the tailings by Mr. B. W. Gandrud, of the U. S. Bureau of Mines, Tuscaloosa Station, showed values up to $2.50 per ton. The ore is amenable to flotation, and such a plant should be erected if good recoveries are to be made.

Mr. W. L. Cotton, of Albemarle, erected a small five-stamp mill at the *Herne Mine* after doing some prospecting and development work. The mine did not show much promise, so was soon abandoned.

At the *Parker Mine* some exploration and development work was done by Mr. E. C. Gallagher, of New York. A small washing plant was erected, and attempts were made to recover gold by an electric process. This did not prove successful on account of the clayey nature of the material. Later, the property was taken over by Mr. E. M. Scott, and further prospecting undertaken. A tunnel was sent into the hillside approximately 200 feet, which cut a very rich quartz vein. A winze was sunk on the vein to a depth of 22 feet, which revealed some very high-grade free-milling ore. Several thousand dollars worth of free gold in large nuggets was taken from this shallow pit. Plans are underway for further development.

At the *Crowell Mine,* the Crowell Mining Company did extensive exploration work and as a result erected a small recovery plant. However, the ore is very low grade and rather difficult of treatment. Recently the mill was dismantled and taken to the *Haile Mine* in South Carolina.

At the *Haithcock Mine,* four miles west of Albemarle, Mr. Ed Snuggs had a shaft sunk on a quartz vein, which showed from 3 to 5 feet in width. Some drifting was also done, which revealed quartz containing free gold. This work, however, was soon abandoned.

At the *Mumford Mine,* near New London, Mr. V. A. Wynne, of Pennsylvania, did some prospecting and development work. The quartz vein showed 1½ feet in width and was traceable

for a considerable distance. However, most of Mr. Wynne's work was confined to the placer material along the creek. He used a Denver machine in testing out the placer material.

At the *Ingram Mine,* owned by Mr. R. L. Smith, of Albemarle, some placer work was done. The tenant, Mr. Simpson, during the summer of 1936, recovered six ounces of very coarse gold, the largest of which weighed twenty-three pennyweights.

Randolph County: The most important development work in Randolph County is at the *Keystone Mine,* by the Keystone Mining Company. The ore is a very large, low-grade deposit, averaging close to $3 per ton. A 200-ton flotation mill has been erected on the property, and several hundred tons of ore treated to date with satisfactory results. In addition to the mill, several residences, office buildings, and a commissary have been erected. It is the most important mining village so far constructed in the State.

The *Hoover Hill Mine,* just north of the Keystone Mine, has also been taken over for development by the Keystone Mining Company. The shafts are to be unwatered, and, as the water is pumped from the mine shafts, the present plans are to utilize it to hydraulic the hillsides. Old reports show that a very large body of reasonably high-grade ore is present.

At the *Jones* or *H and G Mine,* two miles south of Asheboro, E. B. Hendricks and H. L. Griswald have erected a washing plant of ten tons capacity. The ore at this mine consists of a soft slate of volcanic origin quite similar to that at the Thompson Mine. Lying above the slate are 2 to 4 feet of placer material, which is said to carry twenty-five cents per ton in free gold. The slate vein is approximately 20 feet in width and averages about $5 per ton, according to Mr. Hendricks. The gold is not uniformly distributed through the 20-foot vein but occurs in low and high-grade streaks. The plant makes an 85 per cent recovery from this ore. Sixty pounds of concentrates are recovered per ton, which show a value of $150 per ton.

The washing plant consists of a tube mill converted into a ball mill, amalgamation plates, blankets, and sluice boxes.

Below is a report on the Sawyer Mine as taken from Economic Paper No. 14:

The *Sawyer Gold Mine* is situated in Randolph County, North Carolina. It is nine miles northwest of Asheboro, the county

seat, from which town it is reached by main Highway No. 90 and a good sand road. It is also fourteen miles southeast of High Point, from which it is reached by a good sandy, county road. It is one of a group of mines in the central and western part of the county. The country rock is a glistening sericitic quartz schist.

The mine is opened by a main vertical shaft, 150 feet deep, which cuts the vein at 100 feet and the trap dike at 110 to 120 feet. At the 100-foot level are drifts 40 feet each way.

The main shaft is 150 feet deep, but there are a number of smaller shafts—six, opening on the veins. The Carraway Creek runs through the property, affording ample water supply. Two good county roads also run through the property.

There are three main veins, viz., the Miller, Davis and Sulphur.

The Miller vein is simply a more siliceous and enriched zone on the hanging wall side of a dark granite porphyry (diabase), from which it is separated by a darker zone of schist forming a sharply defined wall of the vein. There is no hanging wall, but simply a diminution of the mineralization of the limonite. The mineralized part of the zone is 6 to 50 feet thick, and will probably average 15 feet for the whole length.

Careful sampling by Mr. Kerr gave an average for the hard rock of $6.10 per ton in gold (old price; new price $10.54).

The sulphides begin at a depth of 80 feet and concentrate so well that the tailings only carry about 20 cents per ton, although the pyrites are very fine grained, say 60-mesh, and occur in little bunches or specks. In the wall rock it occurs in cubes up to one inch on a side. The hard granitic-looking rock from the shaft slacks in the air.

This vein was opened for a mile and a half along the outcrop before the Civil War. Near the main shaft are some new workings; one quite extensive new open cut carries specimens showing visible gold in considerable quantities. A sample was taken along four feet, which gave in assaying a value of $14 per ton (old price; new price $24.50). This is soft sericite. At other places the vein is hard laminated quartz, like the ore bodies in the Russell Mine.

Across one opening, 22 feet wide, there is a very careful sample groove which shows how carefully the mine was sampled. Most of the old workings are caved or full of water, and were not examined.

The Davis vein is a 1,200 ft. loop separated from the main Miller vein by a 240 ft. horse including the dike. Where the two unite at the Northeast is a body of $6 (old price; new price $10.50) ore thirty-two feet wide. The supposed junction at the southwest end has not been found.

At the tramway cut the vein shows eleven feet heavily stained with limonite, which repeated assays have shown to average $4.20 per ton (old price; new price $7.11).

There is a shaft just West of this cut with a tunnel along a cross vein, but that ore was a little richer.

The soil in the space between the Miller and Davis veins was found to average $1.69 (now $2.94) a ton by careful sampling in small test pits.

The Sulphur vein is parallel to the Miller vein, some 600 feet Southeast. Near the mill it has been opened to a depth of 60 feet and stoped to the surface for the length of 100 feet. At the surface the vein has a width of 22 feet, of which the richer 6 feet only are stoped. This averaged about $9.20 a ton (old price; now $16.10), and gave 50 per cent concentrates, chiefly pyrite. The average of about 75 samples of the leaner 16 feet was $2.80 (now $4.90).

Where a small road crosses the vein some distance from the stope it shows seven feet worth $0.80 to $1.20 per ton (now $1.40 to $2.10).

Across the main road are old workings on the Sulphur vein 6 feet wide, about 150 feet long and 30 feet at the deepest place. These workings were based on some rich limonite, and there is said to be still a 6-inch streak of limonite in the bottom worth about $100 per ton (now $175).

The *Brummel Hill* workings, which may be an extension of the Sulphur vein, but probably are not, were worked extensively by a number of small owners operating Chilean Mills on the creek below. Some of the shafts are very deep but are full of water except during the dry spells.

For 450 feet next to the creek the zone of irregular workings is about forty feet wide, but the bodies are somewhat irregular and walls are only shown by the disappearance of the gold. In places both the vein and the country rock are very hard and siliceous, resembling quartzite. At the far end of this zone is a large open cut next to a trap cross-dike; 100 tons taken from this gave $2.50 per ton (now $4.23) on the plates.

The vein dips near 45° and the old Pace Workings on the high hill beyond are, therefore, considerably out of line and may even be a separate vein. Here there is a 6 foot vein which carries $9 ore ($15.75) for intervals of about a half-mile to the Northeast. There are a number of trap dikes cutting across the country as well as parallel.

During the summer of 1936 Mr. C. C. Hartsell, Asheboro, N. C., took twenty-one samples frqm the old workings on the Brummel Hill veins, which gave the following results: $4.20, $33.60, $0.80, $27.40, $44.80, $1.15, trace, $3.01, $8.57, $2.90, $36,75, $6.33, $21.56, $4.55, $35.35, $0.80, $4.39, $5.67, $2.83, $2.01, $0.87, $1.05.

In addition to the above developments, some exploration work was done at the Pine Hill, Alred, North State, and Porter mines. The ore at all of these mines, however, is a rather low grade and occurs in a soft decomposed tuff or sericitic schist.

Montgomery County: Probably the outstanding gold development in Montgomery County was at the *Black Ankle Mine,* by the Black Ankle Mining Corporation. When exploration work began at the Black Ankle Mine, it was thought that a very large, high-grade deposit of ore was discovered. However, further development revealed a rather limited ore body of very low grade. In addition to the low gold content, the fine subdivision of the gold particles, which occurred in a rather clayey or decomposed volcanic material, prevented the profitable operation of the cyanide plant. Several gold recovery processes were attempted, but none proved successful, even though approximately $150,000 were spent.

At the *Eury* or *Wade Mine,* four miles north of Troy, a shaft was sunk to a depth of 40 feet, which exposed a quartz vein 2 feet in width. The quartz showed rather high values, but the gold was largely confined to a two-inch streak on the hanging wall side. The quartz vein occurs in a very siliceous slate.

At the *Carter Mine,* Mr. G. W. LaPiere, Geologist from Charleston, West Virginia, erected a washing plant to recover the gold from the stream gravels. However, on account of the lack of funds and the nature of the deposit, the work was soon abandoned.

Another development in Montgomery County was at the *Coggins Mine.* The old mine was unwatered to a depth of approximately 200 feet, and sampled. The results, however, were not satisfactory, therefore all work was discontinued.

Some development work was also undertaken at the *Iola Mine,* on what appeared to be extensions of the Iola vein. The results were not so favorable.

The *Golconda Mine* is located just North of the Iola Mine near Candor, Montgomery County. The property consists of 150 acres.

The shaft is approximately 120 feet deep with two levels, at 50 and 100 feet. The drifts extend approximately 50 feet to the Northeast and 50 feet to the Southwest. At the 100 foot level, the drifts extend about 75 feet each way.

According to Mr. Claude Hafer, Mining Engineer, Southern Pines, N. C., the average value of the ore from the drifts was about $22.00 per ton, with gold at $35.00 per ounce. The vein averages about 3 feet and consists largely of quartz and shows about $20.00 per ton, free milling. The last 30.5 tons milled yielded 15.1 ounces of gold with tailings worth about $5.00 per ton. The slates on the footwall side seemed to be mineralized for some distance, said to be about 50 feet. At 4 feet away from the vein, a similar assay gave the value of $2.00 per ton and pyrite in pit nearer to the surface of these slates.

About 250 feet N. 40° E. from the main shaft, the vein shows in a shallow pit to be about 3½ feet in width. About 150 feet Northeast of this shaft the vein is cut by a diabase dike, but it can be traced to the Southwest to the Montgomery Mine.

Nash, Franklin, Warren, Halifax Counties: In the northeastern gold belt, in the counties of Nash, Franklin, Warren, and Halifax, considerable prospecting and development work has been done. Approximately $200,000 were spent in the purchase of properties, in the development work and in the construction

of a recovery plant. However, since the recovery plant was not suitable for the ores, it operated only a short while. This work was done by the Norlina Mining Company, with capital principally from Detroit.

Since the development work was discontinued by the Norlina Mining Corporation, another group of interests, under the direction of Mr. R. W. Craig and Mr. A. L. McNeer, are doing further prospecting and sampling to determine the extent and value of the placer material for dredging.

During the past seven-year period, approximately $1,600,000 have been expended on gold prospecting, development work, and recovery plants in North Carolina. In July, 1936, seven gold recovery plants were in operation. Many of the smaller plants had been abandoned either on account of insufficient capital or inability of the operators to recover the gold.

Anyone planning to enter the gold mining industry in North Carolina should secure the best technical advice available, thoroughly prospect the property either by crosscutting, tunneling, core-drilling, or shaft work, and sample very carefully, and have a reliable assaying company to make the assays to determine the gold content. After the quality and quantity of the ore have been ascertained, it is advisable to determine the best methods for handling, treating, and recovering the gold. On account of the clayey nature of the ores in the southern Appalachian, and on account of the difference in the nature of the local deposits, it is necessary to work out a flow sheet on each deposit before the construction of a mill. If the above procedure is not followed, in all probability anyone investing money in gold deposits in North Carolina will lose all the funds invested.

GOLD AND SILVER PRODUCTION IN NORTH CAROLINA
FROM 1929 TO 1935

Year	Value
1929	$11,283
1930	22,963
1931	12,956
1932	6,847
1933	13,463
1934	24,056
1935	85,114

ACTIVE GOLD MINING COMPANIES IN NORTH CAROLINA FROM 1929 TO 1935, INCLUSIVE

Name of Owner or Lessor	Address	Name of Mine	Location	
			Town	County
Cabarrus Mining & Milling Company	Charlotte	813 Mine	Georgeville	Cabarrus
Claricy Consolidated Mines, Ltd.	Toronto, Canada	Whitney, Isenhour, Gold Hill	Gold Hill	Cabarrus
C. C. Hartsell	Mt. Pleasant	Cline	Mt. Pleasant	Cabarrus
Furr and Smith	Georgeville	Stallings	Georgeville	Cabarrus
Midas Mining Company	Winston-Salem	Allen Furr	Rocky River	Cabarrus
A. L. Nash	Salisbury	Snyder	Mt. Pleasant	Cabarrus
		Faggart	Concord	Cabarrus
Syndicate, Inc.	Knoxville, Tenn.	Patterson	Kings Mt.	Cleveland
Liberty Mining Corp.	Lexington	Liberty	Lexington	Davidson
B. A. C. Craig	Lexington	Conrad Hill	Lexington	Davidson
E. Webster Stevens	Lexington	Lytton, Empire	Cid	Davidson
Norlina Mining Company	Essex	Portis	Wood	Franklin
W. M. Fulton	Knoxville, Tenn.	Ferguson		Gaston
Gibson Gold Mining Co.	Gibsonville	Gibson	Gibsonville	Guilford
Boylston Mining Company	Asheville	Boylston	Hendersonville	Henderson
Capps Gold Mine, Ltd.	Charlotte	Capps	Charlotte	Mecklenburg
H. Jardine & Company	Charlotte		Matthews	Mecklenburg
Stark Gold Mining Corp.	Charlotte	McCall, Dunn	Charlotte	Mecklenburg
Rudisil Gold Mine Corp.	Charlotte	Rudisil	Charlotte	Mecklenburg
Black Ankle Mining Corp.	Seagrove	Black Ankle	Seagrove	Montgomery
Claude Hafer	Southern Pines	Iola	Candor	Montgomery
Keystone Mining Company	Asheboro	Jones-Keystone, Hoover Hill	Asheboro	Randolph
E. B. Hendriks, H. L. Griswald	Asheboro	Jones or H. & G.	Asheboro	Randolph
Gold Recovery Corp.	Sanford	Gold Hill	Gold Hill	Rowan
Crowell Mining Company	New London	Crowell	New London	Stanly
N. C. Mining Corp.	New London	Parker	New London	Stanly
Thompson Mining Company	Albemarle	Thompson	Albemarle	Stanly
Condor Consolidated Mines	Toronto, Canada	Howie	Waxhaw	Union
A. J. Terry	Charlotte	Moore	Monroe	Union

Below is a list by counties of the old gold mines which have been active in the State:

GOLD MINES IN NORTH CAROLINA BY COUNTIES

Anson..................Hamilton.

Alamance..............Robeson.

Burke..................Mills, Hedge, White Bank, Hancock, Glen Alpine, Carolina Queen, Granville, Hunts Mountain, Vein Mountain.

Cabarrus...............Linker, Meadow Creek, New Nugget, Phoenix or Miami, Reed, Rocky River, Quaker City, Tucker, Johnson, Stinson, Maxwell, Black, Harris, Gannon, Saunders, McMakin, Pioneer Mills, Mauney, Widenhouse, Nugget, Eva Furr, Buffalo, Allen Furr, Montgomery, Barrier, Furness, Gibb, Faggart, Barnhardt.

Caldwell	Corpening, Pack's Hill, Baker, Fleming.
Catawba	Shuford, McCorkle, England, Rufty, Abernathy.
Cherokee	England, Peachtree, Shuford or Catawba.
Cleveland	Near Shelby.
Davidson	Silver Valley (Lead, Zinc, Gold) Silver Hill, Emmons, Cid, Welborn, Conrad Hill, Laffling, Loftin, Eureka, Black.
Davie	Gray, Butler, Isaak Allen, Callahan Mountain.
Franklin	Portis.
Gaston	Kings Mountain, Burrell-Wells, Crowder's Mountain, Patterson, Rhodes, McLean, Duffie, Robinson, Derr, Rhyne, Oliver, Farror, Long Creek.
Guilford	Deep River, Fentress, Oak Hill, Palachian, Pine Hill, Hudson, Hoover, Fisher Hill, Hodges, Twinn, Lindsay, Jack's Hill, Beason, Harland, Beard, Vickory, Lauder, Endy, Ball.
Henderson	Boylston Creek.
Halifax	Davis.
Lincoln	Hoke, Burton, Graham.
McDowell	Bracket-Town, Vein Mountain, Marion, Bullion.
Mecklenburg	Yellow Dog, St. Catherine-Rudisil, Capps, Frederick, Grier, Johnson, Surface Hill, Hayes, McGee, Brawley, Smith and Palmer, McDonald, F. Wilson, Howell, Trotter, Carson, Taylor, Isenhour, Davidson, Blake, Point, Parks, Clark, Hipp, Campbell, Todd, Arlington, McGinn, Troutman, Prim, Abernathy, Alexander, Dunn, Sloan, McCorkle, Cathy, Ferris, Hunter, Moore, Stephen Wilson, Gibson, Neal, Fraxier, Means, Bennet, Kerns, Henderson, Hunter, Tredinick, Ray, Ellington, Blair, Ferguson Hill, Shaffer, Poplin.
Montgomery	Moore, Reynolds, Carter, Sam Christian, Swift Creek, Dry Hollow, Bright, Ophir, Spanish Oak Gap, Island Creek, Deep Flat, Pear Tree Hill, Tom's Creek, Harbins, Bunnell Mountain, Dutchman's Creek, Worth, Morris Mountain, Coggin, Saunders, Sted, Beaver Dam, Griffin, Nall, Russell, Sedberry, Rich Cogg, Iola, Montgomery, Martha Washington, Riggon Hill, Moratock and Black Ankle.
Moore	Elsie, Bell, Grumpusville, Brown, Bat Roost, Shields, Cagle, Clegg, Burns.
Nash	Mann-Arrington, Argo, Thomas, Kearney, Taylor, Mann, Conyers.
Orange	Robertson.
Person	Durgy.
Polk	Red Springs, Weatherby, Potty Adams, Tom Arms, Splawn, Ponder, Riding, L. A. Mills, Carpenter, Hamilton, Neal, MacIntyre, Double Branch, Price.

Randolph	Uwharrie, Winningham, Slack, Davis Mountain, Sawyer, Winslow, Jones or Keystone, Laflin or Herring, Delft, Parish, Bason, Empire, Redding, Southern Homestake, Scarlett (copper), Asheboro, Tolbert, Hoover Hill, Wilson, Kindley, Conroy.
Rowan	Gold Hill, Yadkin, Dunn's Mountain, Reimer, Bullion, New Discovery, Gold Knob, Dutch Creek, Atlas, Bame, Hartman, Negus, Harrison, Hill, Southern Belle, Goodman, Randleman, Roseman, Gold Coin, Park, Union (copper), Drexler, Steele, Butler, Rumpler, Yadkin.
Rutherford	Double Branch, Alta, Idler, Monarch, Carson, Glendale, Ellwood, Leeds.
Stanly	Parker, Whitney, Crowell, Barringer, Haithcock, Hearne, Flint Spring, Henderson, Lowder, Crawford or Ingram.
Union	Davis, Phifer, Price, Black, Brewer, Indian Trail, Union, Bonnie Doon, Howie, Wyatt, Washington, Penman, Grand Union, Lewis, Hemby, Moore Hill, Folger Hill, Harkness, Long, Fag Hill, Dulin, Crump, Smart, Stewart, Lemmonds, Wenona, Crowell, Butterfield, Fox Hill, Secrest, Bonnie Belle.
Wilkes	Mount Zion.
Yadkin	Dixon.

CHROMITE

Some exploration and development work was done on the chromite deposits in the State in 1929 and 1930. However, on account of the decrease in the price of ores, all work ceased in 1930. The most important work accomplished was at the chromite deposit near the Dark Ridge Trestle, on the Murphy Branch of the Southern Railroad, just west of Balsom Gap. At this location an open cut showed a vein of chromite about 2 or 3 feet in thickness, which is associated with the peridotite. Two or three carloads of high-grade material were shipped from this locality.

Some prospecting was done at the chromite deposit near Democrat, in Buncombe County, sixteen miles from Asheville. At this location the chromite occurs principally as small grains in the peridotite. There is considerable sand chrome on this property, which is readily concentrated. A few years ago the U. S. Bureau of Mines made some tests to determine the best methods of concentration of the chromite.

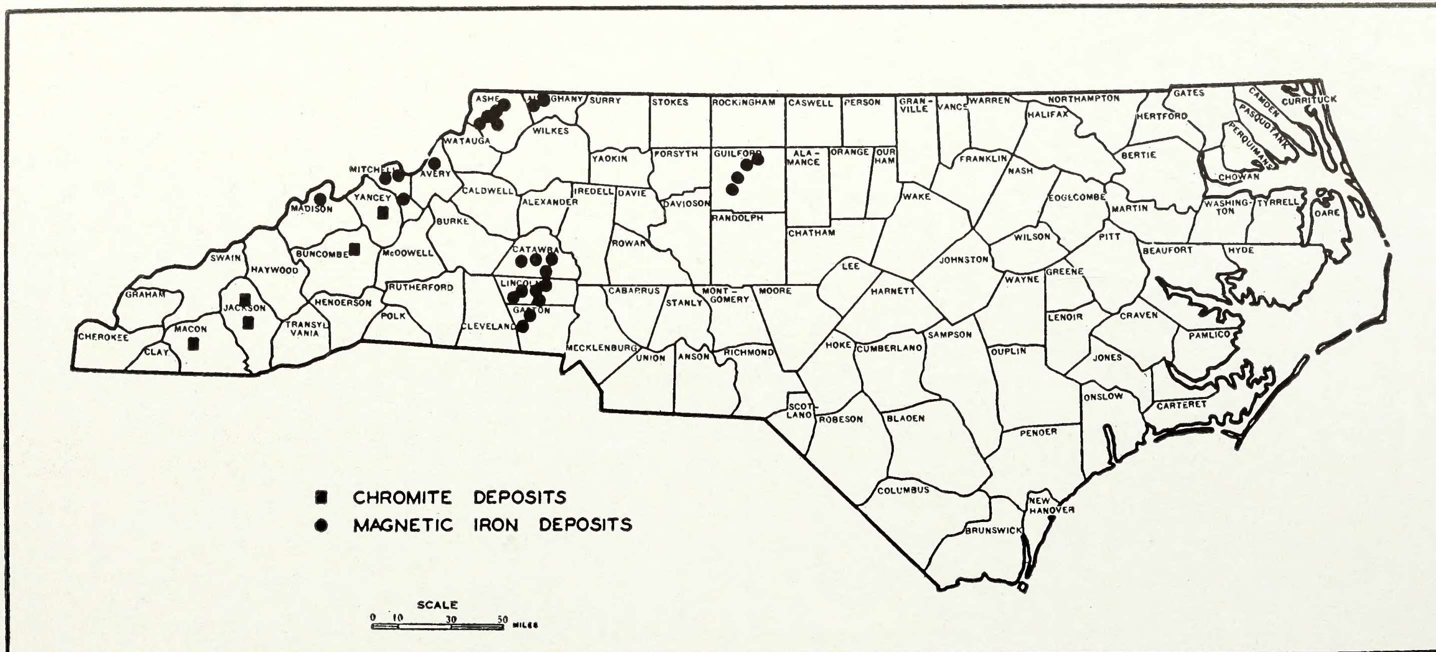


Fig. 3. Map Showing Location of Principal Chromite and Magnetite Deposits

In addition to the two above locations, chromite prospects occur at Mine Hill, on Mine Fork of Jackson Creek, on the Bakersville road, five miles north of Burnsville in Yancey County. The chromite occurs as a narrow vein in the peridotite. The vein at no place showed over 18 or 20 inches in thickness. Selected samples of the chromite showed 58% of chromic oxide, but the ore will not average that high. A sand chromite deposit occurs one mile south of Webster, associated with the Webster peridotite. Some prospecting has been done which shows considerable sand chrome in addition to two or three very narrow chromite veins.

No chromite has been produced in North Carolina since the World War. Since chromium was one of the most important metals used in the War, five mines and prospects reported operations during that time.

COPPER

The copper production in North Carolina decreased considerably during the depression years, but the production for 1935 was about three times that recorded for 1932. The most important producer in North Carolina is the Fontana Copper Mine, Fontana, North Carolina, located in the southwestern corner of Swain County. The maximum production of copper was reached in 1929, when approximately fifteen million pounds of metallic copper were produced. The copper ore at the Fontana Mine is a very high grade and is reported to average about 8% metallic copper. The ore occurs in a schist varying from a typical slate to a talcose schist. The vein varies from a few inches to 30 feet or more in width, and dips at a great angle. The Fontana Copper Company ships the ore to the Tennessee Copper Company for treatment.

During 1929 the Adams-Westfelt property, on Hazel Creek, was prospected considerably by New York interests. Several carloads of very high-grade ore, some of which was reported to carry 12% metallic copper, were shipped from the district. With the decrease in the price of copper the development work ceased. However, the results of the exploration work revealed some interesting deposits, and in all probability these deposits will be further developed in the future.

During 1929 the Tennessee Copper Company leased the Cullowhee Copper Mine from the North Carolina Flux Company. During the exploration and development work four compressed air drills were used, and about forty men employed in the mine. Several hundred tons of ore were shipped from East Laport to the smelters in Tennessee, and it is reported that the ore averaged about 7% metallic copper.

Dr. Clarence S. Ross, Geologist of the U. S. Geological Survey, visited several of the copper districts in the State, and had the following to say relative to the North Carolina deposits:

"The Cullowhee Mine, near Cullowhee, is probably larger and richer in copper than some of the older mines, but it has not been prospected far below the surface. The Ore Knob Mine, near West Jefferson, was at one time the greatest copper mine in the country and for a time utilized the original low-grade ores after the enriched ores above them had been exhausted. The vein is 8 to 16 feet wide and was mined over a distance of 3,800 feet. . . . The Ore Knob Mine is the most promising unworked mine in the region. The vein is continuous for a long distance and contains large reserves of ore similar to that which made it valuable as a mine in the past. The ores are of the same type as those of Ducktown but are probably richer, and the potential copper supplies are large."

Copper deposits of possible commercial value occur in a great number of the western counties, but especially in Swain, Jackson, Haywood, and Ashe. The copper belt of Person and Granville counties also has commercial possibilities, provided the price of copper remains at 10 to 12 cents per pound.

The total production of copper in North Carolina during the past seven-year period has average about ten million pounds annually, but since there is only one company producing copper, the total value of production is not known. The only producer in North Carolina is the Fontana Copper Mine, Fontana, North Carolina.

COPPER MINES IN NORTH CAROLINA
BY COUNTIES

Alamance	Foust.
Alleghany	Peach Bottom.
Ashe	Elk Knob, Miller, Copper Knob, Ore Knob.

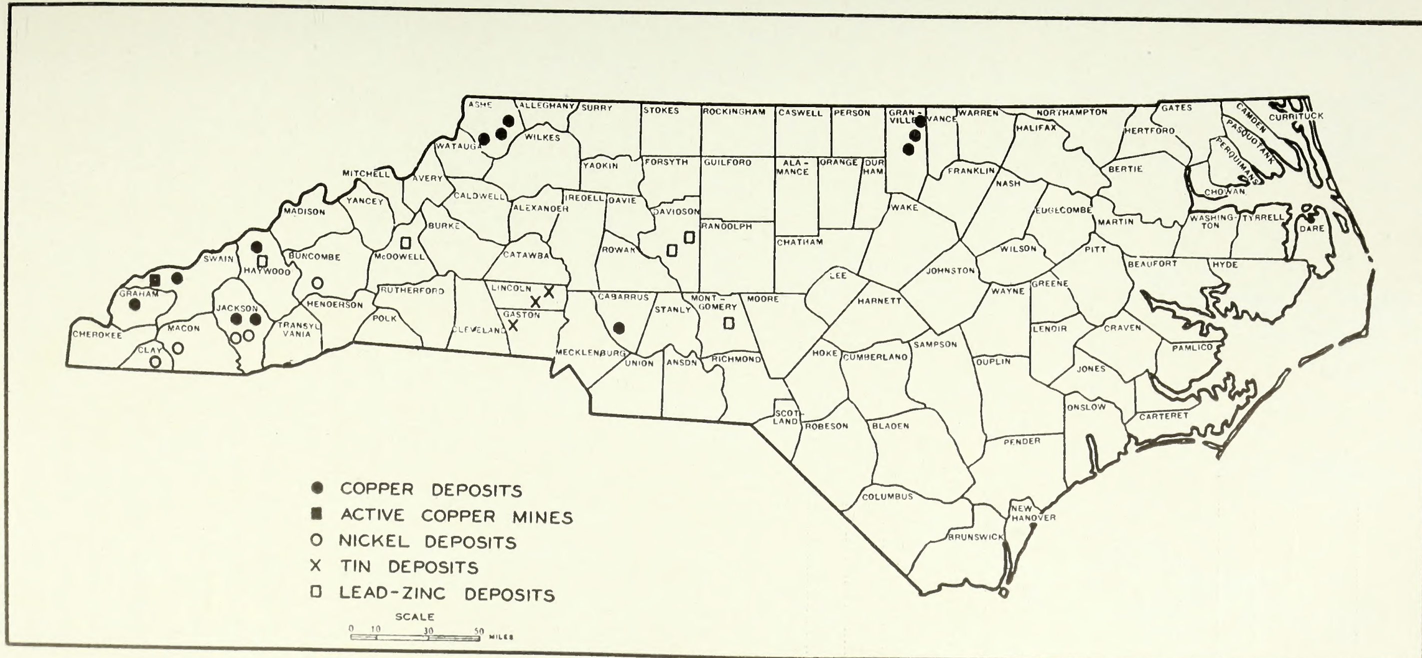


Fig. 4. Map Showing Location of Principal Copper, Nickel, Tin and Lead-Zinc Deposits

Cabarrus	Ludowick, Boger, Hill, Phoenix, Pioneer Mills, Morrison, Crosby (Poplan), Rogers.
Chatham	Clegg, Chick, Phillips.
Davidson	Conrad Hill, Emmons, Cid.
Gaston	Burrell Wells.
Guilford	Hodges, Fisher Hill, Gardner, Lindsay, Jack's Hill, Twin Mine, Fentress, Gardner Hill, North State.
Haywood and Jackson	Waryhut, Cullowhee, Savannah, Shell Ridge, Scotts Creek, Sugarloaf, Panther Knob, Wolf Creek, Blue Wing.
Lincoln	Graham.
Mecklenburg	Roy, Ferris, McGinn, Kerns, Cathey, Dunn, Leary.
Person and Granville	Big America, Holloway, Mastodon, Poole, Buckeye Gilles, Copper World, Yancey, Copper King.
Randolph	Spencer, Sloan.
Rowan	Gold Hill, Dutch Creek, Cline, Dan Hopkins.
Swain	Fontana, Forney, Hazel Creek.

ILMENITE-RUTILE

On account of the new uses for titanium, principally in the manufacture of alloys and paints, some prospecting has been done in North Carolina to determine the economic possibilities of ilmenite and rutile deposits.

Ilmenite is a titanic iron ore and is also known as menaccanite. The composition is $(TiFe)_2O_3$. However, the titanium content usually varies considerably. Rutile is the titanic oxide (TiO_2), but usually contains a little iron.

As new uses increase, ilmenite and rutile will become more valuable, and some of the deposits in North Carolina may be of commercial value.

During 1934 and 1935 the St. Louis Smelting and Refining Company did some core-drilling on an ilmenite deposit in Caldwell County, near Lenoir. Dr. J. H. Steinmesch, of Rolla, Missouri, was sent down to investigate the deposit. Nothing has been decided definitely as to the development of the deposit.

Other ilmenite deposits on which some exploration work was done are located in Ashe County, near Treetop. Under the direction of D. G. Campbell, some exploration work was conducted.

Samples of sands from Albemarle Sound and along the banks of Pungo River, in Hyde County, have shown rather high percentages of ilmenite and rutile. At times thin layers of very high-grade material are encountered.

In Clay County, on Shooting Creek, six miles east of Hayesville, considerable rutile is found in the sedimentary material deposited along the stream and in the upper decomposed layer of country rock. The rutile occurs as small grains and crystals up to an inch or more in diameter. However, little prospecting has been done to determine the per cent of the rutile in the ore.

No ilmenite or rutile has been produced in North Carolina commercially during the last few years.

IRON

On account of the depression, the Cranberry Iron Mine closed, and no production has been shown since 1930. The gangue and stone from the Cranberry Mine has been used as road material in the western counties. However, no iron ore has been produced from that mine in recent years.

Some prospecting for magnetic iron ore was conducted in Ashe County, on the Ballou property, in 1929 and 1930. However, no ore was shipped. During the summer of 1929, considerable interest was shown in the magnetic iron ore deposits of Avery and Mitchell counties. The companies interested were looking especially for a low phosphorous, low titanium, high metallic iron ore, suitable for the manufacture of high-grade steels. Either no deposits were found which were thought to be of commercial value, or the depression caused all exploration and development work to cease. Most of the deposits of high-grade ore in the western counties are practically inaccessible; therefore the future development is uncertain.

The iron ores of the State include all of the chief iron-bearing minerals, as magnetite (the magnetic oxide of iron), hematite (the red oxide), limonite (the yellow oxide), and the bog iron ores. The principal magnetic iron ores occur in Granville, Stokes, Surry, Catawba, Ashe, Avery, and Mitchell counties. The hematite ores are confined to Ashe and Granville counties. The limonite ores occur in Gaston, Madison, and Cherokee counties. The bog ores occur chiefly in the Coastal Plain areas.

Since there was only one producer of iron ore in North Carolina from 1929 to 1935, the Department is not at liberty to publish the figure of production.

LEAD-ZINC

Although North Carolina has not been a producer of lead-zinc ores since 1917, when the production was 2,583 pounds, there was some exploration work conducted in Haywood and McDowell counties.

The lead-zinc deposit in Haywood County occurs in the northern part of the county on Fines Creek in the Catalooche section. The property is owned by the Redmon heirs, and consists of approximately eight hundred acres. The ore occurs in a vein 4 to 8 feet in width and is traceable for three or four hundred yards by outcrops. The vein is principally quartz, with considerable galena, sphalerite, cerussite, and chalcopyrite. Near the surface the ore is principally galena, but at depth it grades into sphalerite and chalcopyrite. A shaft 42 feet in depth showed a 6-foot vein, which contains high percentages of lead, zinc and copper, with a trace of gold and silver. Mr. H. D. McDonald, U. S. Smelting, Mining, and Refining Company did extensive exploration work, but the results of his findings are not known. However, the exploration work did not continue very long. Apparently the results were not very satisfactory.

In the northern part of McDowell County, near the headwaters of North Fork Creek, there are numerous outcrops of a highly fractured limestone in which lead and zinc are found. The chief minerals are galena and sphalerite, the sulphides. The Shady limestone, which is apparently 200 feet in thickness, lies above the Erwin quartzite and is capped with a gneiss. On the northern end of the limestone outcrop along the fault zone considerable galena and sphalerite are found replacing the limestone. Some of these lenses or streaks of lead and zinc sulphides are a foot or more in width. However, from the investigations so far made, the lead-zinc minerals are rather spotty and not uniformly distributed through the limestone.

In the summer of 1935 the American Zinc Company, Mascot, Tennessee, did some exploration work high up on the limestone cliff on the west side of North Fork Creek. The development

work conducted by this company showed some mineralization, but after blasting off several hundred tons of the broken limestone, the investigations were discontinued. However, it is reported that the company still has options on three tracts of land in that vicinity.

In this particular locality the most promising prospects for lead and zinc occur. However, considerable exploration and development work should be conducted before anything definite could be determined. The investigations so far conducted have revealed sufficient material to show that the area has possible commercial deposits of lead and zinc.

Another lead-zinc area, which may have commercial value, was found north of Troy. McGrew and Gibbons, of Philadelphia, did some exploration work on the lead-zinc vein in that section. Several small shafts or test pits were sunk on the vein to a depth of 20 to 30 feet. The No. 1 shaft was sunk to a depth of 20 feet on the northeast end of the property. At the surface the vein showed a width of from 10 to 12 feet and was mineralized the entire width. Assays on samples from this opening showed .16 ounces of gold per ton, 2.4 ounces of silver per ton, and 26% lead. Another shaft, 28 feet in depth, was sunk on the vein, which showed about 5 feet of ore in a vein 11 feet in width. Assays by Booth, Garrett & Blair, of Philadelphia, showed .02 ounces of gold, 2.12 ounces of silver per ton, 15.23% lead, and 26.09% zinc. Other assays were made by C. S. Cowan, of Salt Lake City, from ore on the dumps, which showed a trace of gold, one ounce of silver per ton, from 10 to 20% lead, 19 to 22% zinc, and 1.1% copper. Mr. Cowan said: "It is my opinion that you could make a nice separation of this ore by flotation, making a nice lead concentrate and a high-grade zinc concentrate." The report by McGrew and Gibbons further states: "Colonel Rigby, an old western mining man, after going over this property several times, said: 'Unless the favorable indications fail, there are big ore bodies in this lead and the making of a big mine. . . . At depth, no doubt, smelting ore will be found in quantity, but in a vein like this the big volume and profit will be in the medium and low-grade product. This is what worth-while operators want with modern mining and ore reduction equipment'."

According to the above report, this area has possible commercial value, and is worthy of further investigation and devel-

opment. Mr. W. M. Grant, Mining Engineer, Birmingham, Alabama, tried to purchase the property at one time, but was unable to secure a reasonable agreement with the owners. Mr. Grant seemed to think that it had possible commercial value.

Another very important lead-zinc, silver area is in Davidson County, at the Silver Hill and Silver Valley mines. From exploration and development work so far conducted, these areas are worthy of further development.

MANGANESE

During 1929 and 1930 considerable prospecting and development work was done on the manganese deposits in Cherokee County, southwest of Murphy, and in Transylvania County, near Pisgah Forest.

The Interstate Ore and Metal Corporation purchased 1,100 acres of land, five miles southwest of Murphy. A shaft was sunk to a depth of 40 feet on a large quartz vein, carrying streaks of manganese. As a result of the prospecting done, a concentration plant was erected. The plant consisted of the necessary grinding units, jigs, and concentration tables. Approximately $25,000 were spent in exploration and development work, and in the construction of the plant. One carload of 60 tons was shipped in 1930, but on account of the high silica content and the low manganese (about 38%), no further shipments were made. The plant soon closed and was later dismantled.

In Transylvania County, two miles west of Pisgah Forest, nodular manganese ore occurs in a soft decomposed slate. A shaft was sunk to a depth of 60 feet, with some crosscutting, but because of the nature of the ore, the prospecting was soon discontinued. Apparently nothing of promising commercial value was uncovered. The nodules of manganese showed 58%, but was of indefinite quantity.

Other deposits of manganese of possible commercial value occur eight miles east of Hayesville, Clay County; near Sparta, in Alleghany County; west of Lenoir, in Caldwell County; and on Shutin Creek, in Madison County. A deposit is also reported in the western part of Cherokee County.

During the period 1929 to 1935, only two carloads of manganese were shipped from the State. These shipments were made to steel companies in Birmingham.

NICKEL

During the past three years considerable investigations have been made on the low-grade nickel deposits of Jackson County. The recent investigations have been confined largely to the peridotite area near Addie on the Southern Railroad. A great number of the samples have been taken which have shown a nickel content usually less than one per cent, but in some instances the nickel content was unusually high. Several shallow test pits were sunk on the property, and a number of samples were taken from each pit and analyzed by commercial chemists. In addition to the nickel, small amounts of cobalt were also found.

At the present time a number of properties are under option by New York capitalists, and further development work is planned.

The geologic formations are pre-Cambrian in age and belong to the group of rocks known as the Carolina and Roan Gneisses and schists. The strike of the formations is in a general northeast-southwest direction, much folded, therefore dips to the northwest and southeast. These older metamorphics are intruded with large dikes, stocks and bosses of basic igneous rocks known as "peridotites." There are several phases of these rocks, all more or less basic in nature, known as peridotites, dunites, harzburgites, bronzitites, websterites, and troctolites.

These basic igneous rocks were intruded into the older rocks under high pressure. Later earth movements fractured and squeezed the basic intrusions, causing considerable jointing. In these joints and fractured zones are found the nickel silicates, garnierite and genthite.

The largest peridotite area in the State, and in many respects the most remarkable one in the Appalachian region, occurs at Webster. The area of exposure of these rocks approximates three-fourths of a square mile, but it lacks the compactness of the Buck Creek area, which is next in size, and the usual lenticular form is almost entirely lacking. The line of outcrops traces an almost unbroken ellipse, passing through Webster at the southwestern end and near Addie at the northeastern extremity of the major axis. This axis is six miles long and lies about N. 25° E. The minor axis is about 3½ miles long. The width of the outcrop varies from more than 1,600 feet at Webster to thin

belts of schistose talc, 10 feet or less, at several places. On the eastern side of the ellipse, along Cane Creek, the continuity of the outcrop is broken in five places within a distance of a little more than a mile. The four disconnected masses have the usual lenticular form.

Lateral projections of various forms extend from the main body of the peridotite into the surrounding gneiss in five places. Also, one mile northwest of Addie, a lens-shaped area of gneiss, about 450 by 1,300 feet, is entirely surrounded by peridotite. Throughout the Appalachian region these rocks frequently exhibit more or less lamination, but this character is seldom so highly developed as in the vicinity of Webster. It is particularly well known in the large barren outcrop at the Tuckaseegee River. The lamination is so minutely developed that it is clearly seen in the hand specimen. So far as observed, the lamination in this vicinity conforms to that of the gneiss. The gneiss dips toward the southeast and northwest, away from the major axis of the peridotite ellipse, and, in general, the dip is steeper farther away from this axis, indicating an anticlinal structure in the form of an inverted boat.

At the western border of the large outcrop at the Tuckaseegee River, two shallow cuts show an interlamination of the dunite with the gneiss, like that observed near Elf, in Clay County. The cuts show the following succession: (1) gneiss to the west; (2) laminated dunite 10 feet; (3) thinly laminated gneiss 6 feet; (4) dunite, western border of main mass. In the town of Webster, also, an outcrop in the street just south of the courthouse shows 12 feet of dunite, conformable to the lamination of the gneiss and near the western border of the principal dunite outcrop.

Throughout the entire peridotite belt in Jackson County, there are lenticular masses of talc (sepiolite), vermiculite, asbestos (amphibole), and other metamorphic minerals, which are the result of the metamorphism and consequent alteration of the dunites. All of the analyses which have been made of the above minerals show rather high percentages of NiO, some of which ran above 15% NiO. It is not understood why these metamorphic minerals should show such a high NiO content unless it is because of the mineralizing solutions depositing NiO as a replacement in these minerals.

The massive dunite, which at times shows little or no alteration, contains low percentages of NiO, which is apparently in the form of garnierite and genthite.

During the investigations in that area none of the nickel sulphides, as pyrrhotite and niccolite, have been encountered. However, these two minerals have been reported from the Webster area. All of the nickel-bearing minerals which have been encountered so far are the silicates, as garnierite, genthite, sepiolite, vermiculite, chlorite, asbestos (amphibole variety), and other minerals which are alteration products of the above group.

The nickel-bearing minerals are not uniformly distributed throughout the peridotite rocks, but are more or less confined to certain definite zones paralleling the schistosity of the inclosing rocks. Some of these mineralized streaks or zones are from 50 to 75 feet in width, but are usually much thinner. Sufficient exploratory work has not been conducted to determine the limits of the mineralized bodies, neither as to length and width nor depth, except on the extreme northeastern outcrop north of the village of Webster. In this particular locality reports are available which show enormous tonnages, up to 350,000,000.

The area taken as a whole shows enormous tonnages; so great is the tonnage that it is impossible to estimate with any degree of accuracy the amount of material available. The area, as described above, is in the form of an oval, approximately six miles long, and the peridotite zone varies from a few feet to 1,600 feet in width. The only core-drilling so far done did not exceed a depth of 200 feet; therefore, it is of unknown depth. However, since the formations are basic intrusions, they should have considerable depth.

Since the peridotite formations outcrop over a large area and are well exposed on the hillsides, sampling has been confined largely to surface outcrops. However, in some localities, cross-cutting and some tunneling have been done, but in no place to exceed 20 or 30 feet.

The results of the sampling have shown a rather wide analysis, varying from less than 1 per cent to 14.2 per cent NiO, and in one instance to 18 per cent NiO. Below is given the analyses of material from samples taken:

ANALYSES OF NICKEL ORES, JACKSON COUNTY

Sample No.	Percent NiO	Sample No.	Percent NiO
1	0.35	15	0.90
2	0.23	16	0.53
3	0.39	17	2.56
4	15.91	18	1.30
5	17.84	19	0.35
6	0.35	20	13.10
7	1.05 (25 lbs.)	21	15.96
8	1.30	22	6.45
9	0.27	23	8.11
10	0.45	24	0.51
11	1.70	25	18.55
12	2.15	26	7.45
13	0.26	27	0.47 (5 lbs.)
14	0.87		

The above samples of material weighed from one pound to 3,800 pounds, carefully quartered and analyzed.

The following statement was taken from the Asheville Folio, published in 1904, by the U. S. Geological Survey: "Extensive tests of nickel deposits have recently been made near Webster, about forty miles southwest of Canton. The best ore there is stated to contain as high as 7% of nickel, and the quantity in sight is large. In that case it has been difficult to find a suitable commercial process for the reducing of the ore."

In Economic Paper No. 34, by the North Carolina Geological and Economic Survey, published in 1914, is found the following statement: "The only attempt that has been made to mine any of these nickel ores has been at Webster, Jackson County. This property has been developed by means of sixty open cuts and pits, and one tunnel 154 feet long. Diamond drilling has also been carried on, the deepest hole being sunk to a depth of 162 feet. It is reported that an average sample of the ore, that is expected, will be treated in the electric furnace erected for this purpose, will run 1.75 per cent nickel. It is not known whether this assay represents the run of the rock, or those portions of the rock which contain the seams and particles of nickel silicate."

TIN

The tin deposits of the Carolinas are confined to a narrow strip of territory from Gaffney, South Carolina, in a generally northeasterly direction to Lincolnton, North Carolina. The most important deposits are the Ross Mine, at Gaffney, South Carolina; on the southern end of Chestnut Ridge, near Kings Mountain; on the Jones plantation, seven miles northeast of Kings Mountain; and on the Rhyne estate, two miles southeast of Lincolnton.

The tin ore occurs in the so-called greisen veins, which are for the most part in the mica schist adjoining the gneiss. These veins are more or less lens-shaped, and may be found outcropping at various places for a distance of several miles. The tin-bearing mineral is cassiterite (SnO^2), and contains, theoretically, 78.6% metallic tin.

These deposits have been known for several years, and were reported upon by Joseph Hyde Pratt and Douglass B. Sterrett in 1904.

The price of tin at that time was between twenty-five and thirty cents per pound, while the price at the present time is between forty-five and fifty cents per pound.

In 1929 the North Carolina Mining Company did some exploration work just south of Kings Mountain. Two shafts were sunk on the west vein, one to a depth of 150 feet and the other to a depth of 75 feet. At this locality the greisen vein is from 5 to 7 feet in width and carries 2 or 3 per cent cassiterite.

A small concentration plant was erected for testing purposes, but it was found that the tin content was too low to be of commercial value. Also, the concentration plant was not suitable for that type of ore.

During the past six years the American Consolidated Tin Mines, of New York City, has been doing considerable exploration and development work on the tin deposits on the Rhyne estate two miles southeast of Lincolnton.

The development work in the Lincolnton section is under the direction of Lewis H. Hepp. A steam shovel has been used to uncover the pegmatite intrusions. Two or three trenches, 150

feet or more in length and 15 to 20 feet in depth, have been made across the strike of the tin veins, for the purpose of determining the number of veins and the character of the ore.

At one place near the central part of the deposits a large hole was sunk to a depth of 30 or 40 feet on one of the wider dikes or veins. At the bottom of this hole several crosscuts and drifts have been made to determine the width, extent and nature of the ores.

In the early part of 1936, Mr. Hepp announced to the press that a very rich streak of tin ore, showing from $25 to $50 per ton, had been encountered. He said: "This work has finally resulted in the opening up of six well-defined bodies of ore-bearing material, some of which runs high in metallic tin and much of it giving commercial assays. The most recent find indicates that these mineralized reefs traverse the property, some of them for at least around a mile and a quarter. When the property goes into production, it will be the only commercial tin producer of any importance in the United States. The presence of tin-bearing ore in Lincoln County has been known for many years, but it has never been worked on a commercial basis."

The development work is to continue until sufficient ore is blocked out to meet the needs of a concentration plant. According to the above announcement, very good ore has been encountered from time to time, and if sufficient ore is blocked out, the company plans to erect the plant.

NONMETALLIC MINERALS

ABRASIVE MATERIALS

The most important abrasive materials found in North Carolina are garnet, corundum, spinel, and millstone. During the past few years, only millstones have been produced commercially.

In the early part of 1935, Mr. Paul McJunkin, of York, Pennsylvania, did some further work on the rhodolite garnet deposits in Jackson County, just south of Willets. At this location a rhodolite garnet schist carrying from 10 to 40 per cent garnet has been explored to considerable extent. In 1923 the Rhodolite Company, LeRoy, New York, built a 100-ton concentration plant. However, this plant did not operate successfully on account of the nature of the garnet schist. The deposit con-

tains, near the hanging wall side, considerable sulphides, which caused trouble in separating the garnet from the gangue. It is reported that several hundred thousand dollars were spent in trying to work out a successful method of concentration from a commercial standpoint.

Some work was done on the garnet deposits in Clay County, near the headwaters of Shooting Creek. The garnet in this section is almandite and occurs as large crystals, some of which reach 6 or 8 inches in diameter, in a hornblende gneiss. Numerous tests showed that the garnet made up 16% of the rock mass.

Near Rainbow Springs, on the headwaters of Natahala River, in the extreme western edge of Macon County, there is a large deposit of kyanite-garnet schist, which has commercial possibilities. Concentration tests on this schist showed 30 to 40 per cent garnet and approximately 40 per cent kyanite. A very good separation was made. After the tests were completed and some development work conducted, the company planned to erect a concentration plant, but so far nothing definite has been decided.

In 1930 some investigations were made on the headwaters of Buck Creek, in Macon County, to determine the economic possibilities of a corundum schist. The corundum occurs as lenticular crystals surrounded by margarite mica. No commercial method of concentration has been worked out to separate the corundum crystals from the mica. Dr. O. C. Ralston, of the U. S. Bureau of Mines, plans to make some concentration tests in the near future on the corundum schists.

During the past few years the millstones produced in North Carolina have come entirely from Rowan County. The stones, buhr stones and chasers, have been hewed from the light-colored granites in the vicinity of Faith and Salisbury. On account of the business conditions, the production has been small, and only one producer has shown a production during the past few years. The Department is not at liberty to show the total value of production.

ASBESTOS

The minerals which have been mined and sold under the name of asbestos, include: actinolite and anthophyllite, the amphibole, and chrysotile, the fibrous form of serpentine. Asbes-

tos occurs in three different ways: (1) cross fiber, fibers transverse to walls, which is usually the chrysotile and rarely anthophyllite; (2) slip fiber, fibers parallel to walls, which is either chrysotile or amphibole; and (3) mass fiber which has the fibers in bundles or groups.

In this State the amphibole, chiefly anthophyllite, is the most important variety found. The chief occurrences are as follows: in the southwest section of Ashe County; along the North Toe River, four miles from Minneapolis in Avery County, where the largest deposit in the State is found; in Caldwell County near the old Baker Mine; near Norton and on Commissioner Creek in Macon County; the amphibole, anthophyllite and fibrous enstatite near Ledger and Bakersville; in Yancey County on the south side of Green Mountain and two miles to the northeast of Micaville.

During the past few years the anthophyllite asbestos deposits have been prospected to some extent, especially those in Avery, Yancey and Macon counties. Several properties in Macon County have been optioned by northern interests.

New uses and new methods of treatment for the low-grade asbestos have caused the recent interest. This form of asbestos is especially suitable for boiler and pipe covering and for the manufacture of heat and sound insulation products. Also, it has been used to some extent recently in cement shingles and in composition flooring materials. On account of these new uses and the new developments in this particular field, in all probability some of the more important asbestos deposits will be prospected and developed further.

BARYTES

Barite, or barytes, as it is known commonly, a sulphate of barium ($BaSO^4$), is a heavy white crystalline mineral with a perfect prismatic cleavage and is found rather widely distributed in nature. It does not usually occur in well-defined veins but is more often found in a series of pockets or lenses of varying dimensions. These are more or less in line, often filling the dip of the rock with which they are associated, which in most cases is limestone. In some instances the rock is entirely decomposed and the pockets of barytes occur in clay. A mineral commonly associated with barytes is galena, a lead sulphide. On account

of the alteration of the rocks with which the barytes is associated, it is usually more or less iron-stained so that it is often necessary for the barytes to be ground, washed, and bleached with acids in order to purify it. Some, however, is found of sufficient purity so that it does not need any washing or bleaching whatever.

The principal barytes deposits of North Carolina are in Madison County in the vicinity of Marshall, Stackhouse, Sandy Bottom and Hot Springs; and in Gaston County, about five miles from Bessemer City. North Carolina barytes is of good quality and occurs in large quantity. There has been no production in this State during the past few years.

Since the barytes deposits in North Carolina apparently contain large tonnages of available materials, several companies have shown interest. Samples of North Carolina barytes have been sent to various companies for concentration tests. Since most of the North Carolina material contains varying amounts of impurities, as fluorite, quartz, and galena, it will have to be concentrated before being marketed. The methods of concentration so far conducted have been air flotation and froth flotation.

The company in Cleveland, Ohio, took samples from several of the North Carolina barytes deposits and conducted certain concentration tests by the air flotation method. The engineer representing the company said that the most important step in the air flotaion method was a concentration table in which very small holes were drilled to permit the flow of air through the table. The table vibrated as the ordinary wilfley table, but the small jets of air under varying pressures caused the separation of the barytes from the gangue minerals.

The methods of concentration employed by the U. S. Bureau of Mines, under the direction of B. W. Gandrud, of the Tuscaloosa Station, Tuscaloosa, Alabama, is the froth flotation. It has been reported that some progress has been made with the froth flotation method on several nonmetallic minerals.

If these flotation methods prove successful, many of the barytes deposits heretofore not developed will have possible commercial value in the future.

CLAYS

The kaolin deposits of North Carolina are confined principally to the Mountain district. These deposits are of the residual type, which are the result of the weathering or decay of the pegmatite dikes and granites. North Carolina has long been the leading producer of residual clay in the United States. It is used chiefly in the manufacture of china, porcelain, and semi-porcelain ware; spark plugs, glass melting pots, and different types of tile. Its chief use in the body is to serve as a bond.

Beginning in 1927, and continuing through to the present time, several companies became interested in the North Carolina kaolin deposits, first to determine the best methods of recovering the mica as a by-product, and second to improve the methods of refining the clay. Until that year all of the clay-washing plants operating within the State discharged mica direct into the streams, which resulted in a loss of several thousands of dollars annually. However, with the improvement and finally the perfecting of a process for recovering the mica, the scrap mica by-product is about as valuable as the clay itself. Mr. Harry Gaines of Canada was the first to work out the process, and since that time, all the clay recoverey establishments have adopted his methods of mica recovery.

Soon after the successful completion of the mica recovery process, the companies operating in the State saw the need of improving the grade of the refined clay. By the old processes, which have been in operation in North Carolina about 35 or 40 years, the clay was rather non-uniform, and companies purchasing the product could not depend on the material. A carload of clay would be shipped to a consumer, which ran about 90 per cent pure, then from the same deposit another carload would be shipped which would only run 70 per cent pure. On account of this non-uniform condition, the residual clays of North Carolina were thought to be of low grade and not dependable. Also, reports formerly prepared by the State gave low estimated tonnages of clay in reserve deposits, which led many companies to believe that the North Carolina clay deposits were of limited extent. In view of these facts many of the larger clay-producing companies could not be interested in investing in the North Carolina deposits. However, through the pioneering efforts of the Division of Mineral Resources of the North Carolina De-

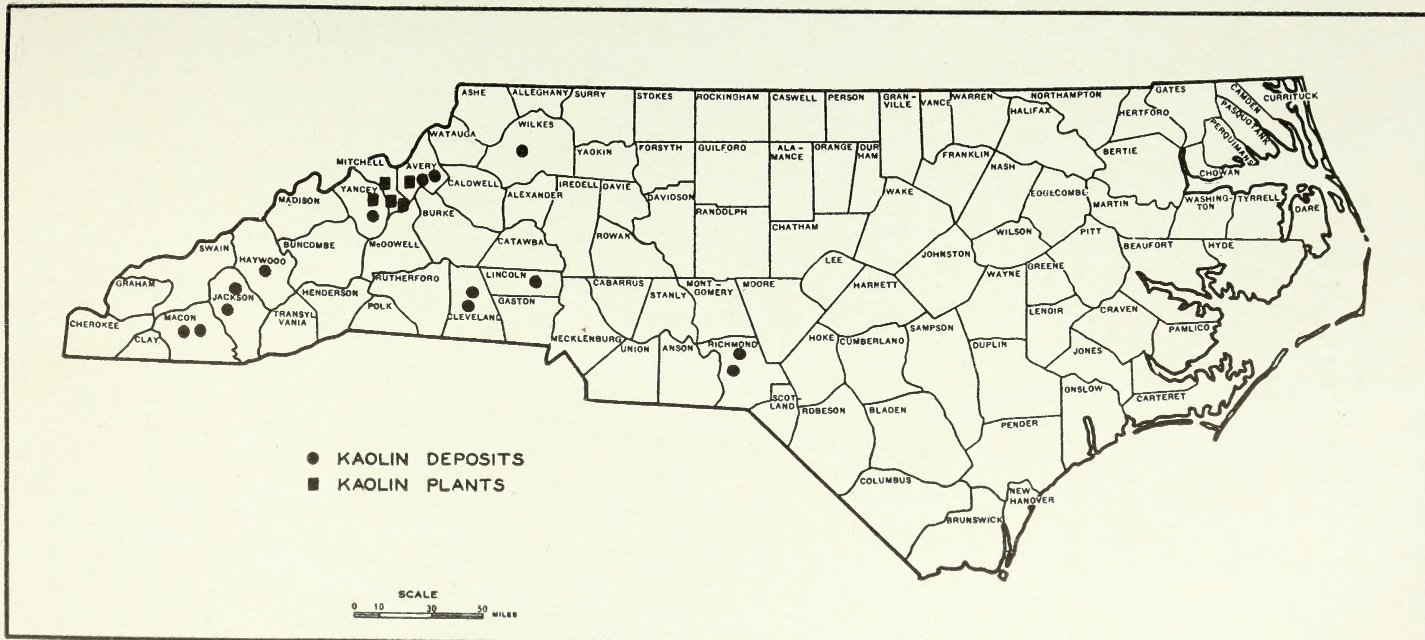


FIG. 5. MAP SHOWING LOCATION OF THE MOST IMPORTANT KAOLIN DEPOSITS AND ACTIVE KAOLIN RECOVERY PLANTS

partment of Conservation and Development, a group was convinced that the North Carolina clays did exist in large quantity, and if properly refined, could be produced in such quantity and of such quality to compete with English clays. Mr. C. R. Ricker, formerly of New York, and associates, purchased large tracts of clay-bearing properties in Avery County. Since the purchase of these properties, on which several millions of tons of clay have been blocked out by pitting, tunneling, and drilling, beneficiation tests have shown that the North Carolina clays are equal to, and in some respects superior to, English clays. The company, Kaolin, Inc., of which Mr. Ricker is an officer, in cooperation with the Ceramic Department of the Tennessee Valley Authority, the U. S. Bureau of Mines, companies throughout the United States, and companies abroad, have proven that the North Carolina kaolins can be properly processed to meet the specifications of the most critical consumers. As a result of this cooperative work, North Carolina will become one of the leading producers of high-grade kaolin clays.

R. E. Gould, Chief Ceramic Engineer, Tennessee Valley Authority, says that "The refined primary kaolins have in the past been used quite extensively, although very limitedly in some branches of the pottery industry in the United States. The reason for the limited use was due to the refining methods which delivered a product not only non-uniform in quality but also almost entirely lacking in plasticity and dry strength, two very necessary characteristics for the pottery industry. Proper methods of refining change the physical state of the refined final product, and it has been found that this kaolin is quite remarkable, developing a high plasticity, a good dry strength, and very fine burning characteristics. It is believed that with the commercial production of the better refined material it can be substituted for the now imported English kaolin in the entire whiteware ceramic industry as well as for a basis for different types of finished products which are now exclusively imported from abroad."

The Ceramic Department of the Tennessee Valley Authority has shown that a high-grade china can be manufactured from the North Carolina clays, feldspars and quartz, without the addition of ball clays or the English clays. Most ceramic engineers have believed that the North Carolina kaolins did not have plasticity; however, as a result of the tests conducted by the

Ceramic Department of the Tennessee Valley Authority, the clays show a high plasticity. On account of this high plasticity, pieces of ware can be molded in four minutes as compared to 50 minutes to 90 minutes for other clays. As a result of these properties which the clay has when properly refined, a good grade of ware can be manufactured at very low cost.

The most important developments in the clay-mining industry in North Carolina in recent years is the construction of a kaolin recovery plant by Kaolin, Incorporated, in the southern extermity of Avery County, with an initial production of 30 tons of refined clay and from 20 to 30 tons of scrap mica per day. News articles report that the total investment involved in the developments of the Kaolin, Incorporated, will exceed $500,000. This plant is probably the beginning of a great clay and pottery industry for North Carolina.

Soon after the announcement of the erection of the plant by the Kaolin, Incorporated, the Harris Clay Company began the construction of a large clay-washing plant at Lunday, just west of Spruce Pine.

The two above plants are a great step forward in the clay industry in North Carolina. These plants plan to produce a clay of 99 per cent, or better, purity as compared with the present material of 70 to 80 per cent purity. The companies propose to guarantee uniformity of the product. These clays will then compete with the English clays rather than with other American-produced clays. Since the United States imports from two to three hundred thousand tons annually of English clays, the market possibilities for the North Carolina product are large.

It is rather difficult to give an estimate of the kaolin present in the known deposits in western North Carolina. Bulletin No. 29, "The Kaolins of North Carolina," by W. S. Bayley, prepared in cooperation with the U. S. Geological Survey and published by the North Carolina Geological and Economic Survey, says: "In the case of the deposits that are now being exploited and of those that have been explored by boring, it may be estimated that the reserve is over 400,000 tons of commercial kaolin. This is a much lower figure than that arrived at by the owners of some of the kaolin properties in this area, but in their estimates it has been assumed that all of the kaolin in the ground can be removed, which is not the case."

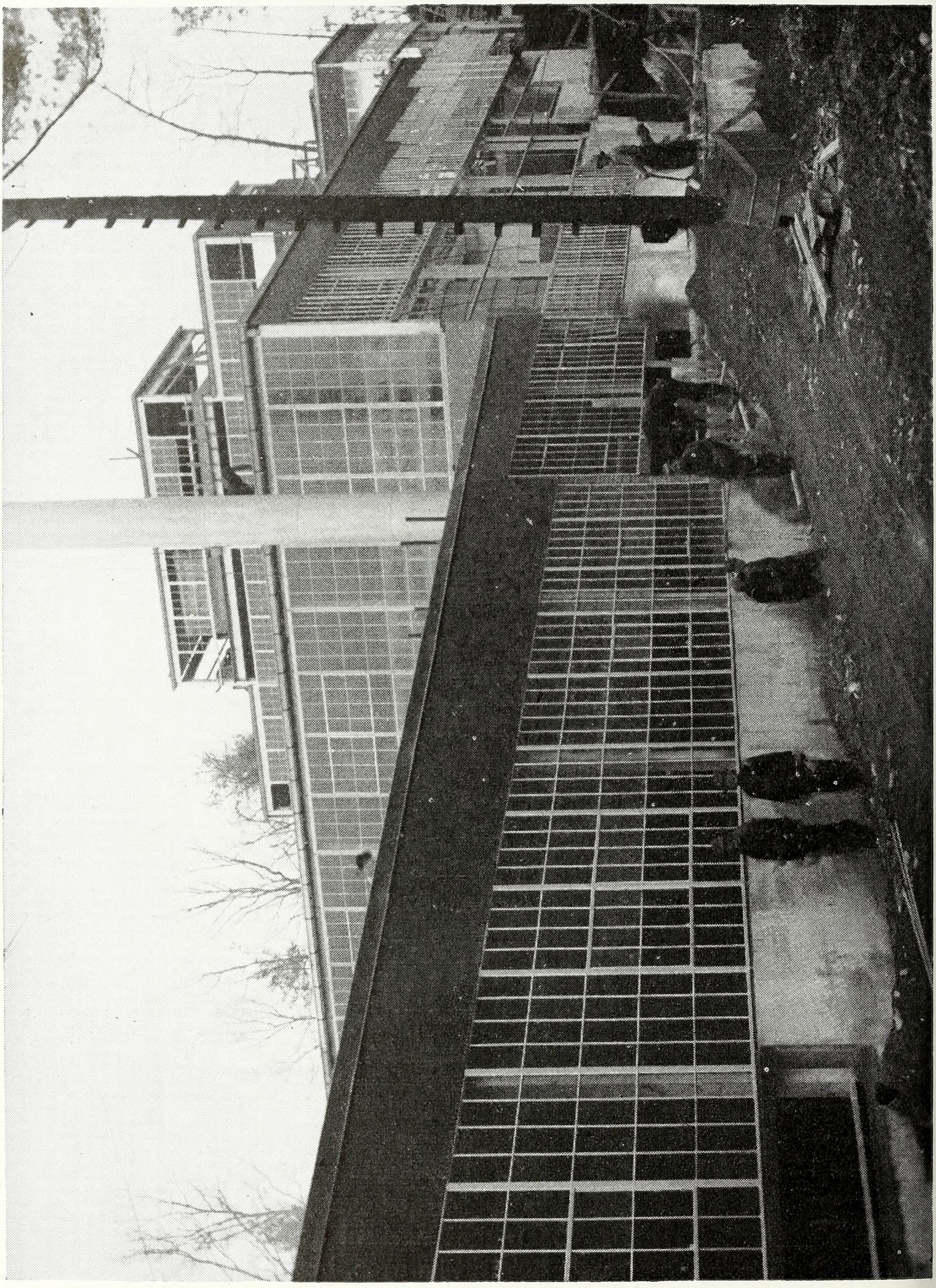


Fig. 7. End View of Kaolin Recovery Plant Showing Loading Shed, Kaolin, Inc., Spruce Pine

Since the publication of the above report, all of the clay companies interested in developing the clay deposits in western North Carolina have hesitated to invest even small sums to investigate the deposits. Also, in many of the technical schools of the east, members of the faculty lead one to believe that the kaolin deposits in North Carolina are small lenticular deposits of limited extent. Also, many of the consumers believe that the clays are of low grade, and consequently are of little or no commercial value. The above beliefs are erroneous because it is only within the past six years that systematic prospecting has been accomplished to determine the extent of the known clay deposits. It is within this same period that companies, in cooperation with the U. S. Bureau of Mines and the Tennessee Valley Authority, have worked out and fully determined the best methods of refining the North Carolina kaolins.

As a result of the investigations, the kaolin reserves have been increased from the 400,000 tons estimated in Bulletin No. 29 to approximately 25,000,000 tons, calculated on an average yield of usable plastic material on a 15 per cent basis of recovery. The large deposits discovered in Avery, Yancey, and Mitchell counties show 22,000,000 tons. To these may be added approximately 3,000,000 tons which have been developed in other deposits in Haywood, Macon, Jackson, Swain, and Clay counties. In addition, there are deposits of possible commercial value in Ashe, Wilkes, Davie, Lincoln, Cleveland, and Richmond counties.

According to investigations so far conducted, it is believed that the primary kaolin reserves in North Carolina will supply the needs of the consumers in America for many years to come. In view of the fact that the total consumption in the United States is approximately 300,000 tons annually of primary kaolins, the known reserves will supply the demand for approximately 75 years.

Production

The production of kaolin in 1929 was 17,683 tons valued at $282,682, which was 2,215 tons and $16,269 in total value less than the production for 1928. The greatest production on record was in 1930, when 24,759 tons were produced. However, there was a gradual decrease in production until 1934, when only

6,928 tons were produced. The production in 1935 had increased to 8,312 tons. With the new developments in Mitchell County, it is believed that the future production will greatly exceed that of the past.

PRODUCTION OF CLAY (KAOLIN) IN NORTH CAROLINA FROM 1929 TO 1935, INCLUSIVE

Year	Tons	Value	Average Price Per Ton
1929	17,683	$282,682	$15.98
1930	24,759	391,571	15.85
1931	12,287	195,700	15.93
1932	12,946	202,528	15.62
1933	6,928	102,814	14.84
1934	7,146	106,742	14.93
1935	8,312	119,272	14.34

During 1935, five clay plants were in operation distributed among three producers. Mitchell County continues to lead in the production of clay.

PRODUCERS OF KAOLIN IN NORTH CAROLINA IN 1935

Name of Company	Address	Plant Location	
		Town	County
Southern Mica Company	Erwin, Tenn.	West Mills	Macon
Harris Clay Company	Dillsboro	(Sparks, Siding	
		(Penland, Spruce	Mitchell
		(Pine	
Carolina China Clay Co.	Penland	Penland	Mitchell

The Harris Clay Company, the chief producer, operated four plants in 1935, which are located in Mitchell and Yancey counties.

BRICK AND TILE CLAYS

The brick and tile clays of North Carolina are distributed throughout the State. Almost every county in North Carolina has clays suitable for the manufacture of brick and tile; sixty-four of the one hundred counties have shown a production in the past.

The principal deposits, and the area from which the largest production has been made, occur in Lee and Chatham counties and in Rockingham and Forsyth County in the Triassic formations; the pre-Cambrian formations in Union, Stanly and Montgomery counties; the river-bottom clays in Lenoir County; and the river-bottom clays along the French Broad River in Henderson and Buncombe counties.

During the past seven-year period, no new brick and tile plants have been built. Instead many of the older plants have gone out of production. One or two have been destroyed by fire and several others have fallen down through disuse.

The table below gives the total value of the production of brick and tile in North Carolina from 1929 to 1935.

TOTAL VALUE OF PRODUCTION OF BRICK AND TILE IN NORTH CAROLINA FROM 1929 TO 1935, INCLUSIVE

Year	Total Value
1929	$3,139,723
1930	1,673,773
1931	1,113,961
1932	538,721
1933	1,002,265
1934	1,100,685
1935	1,200,000

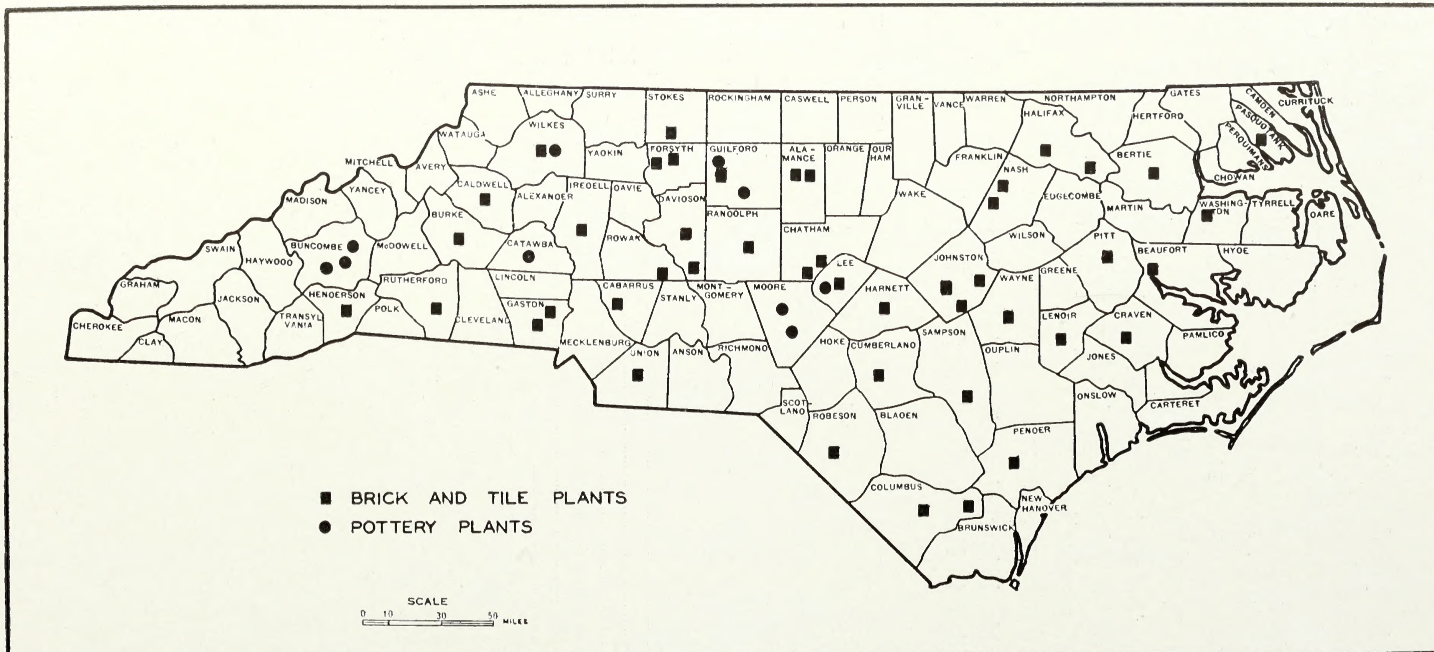


Fig. 8. Map Showing Location of Brick and Tile and Pottery Plants Operating in 1935

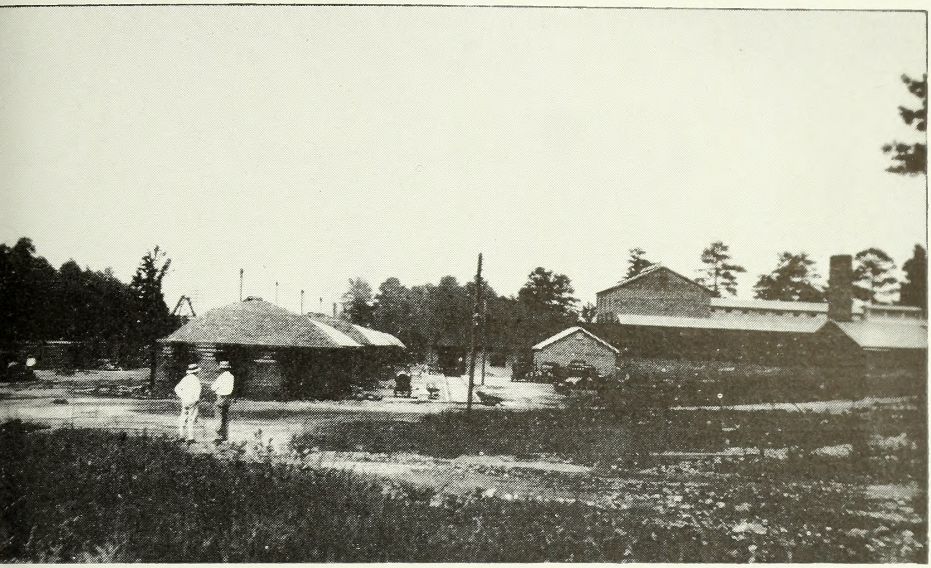


Fig. 9. Brick Plant near Sanford, Lee County

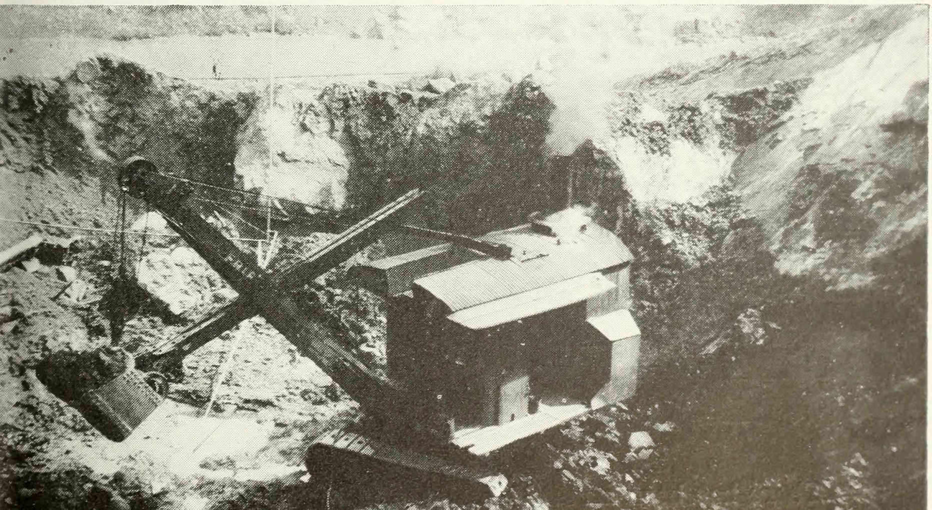


Fig. 10. Brick Clay Pit, near Sanford, Lee County

BRICK AND TILE PRODUCERS IN NORTH CAROLINA IN 1935

Name of Company or Producer	Address	Plant Location	
		Town	County
W. T. Jeffrys	Graham, N. C.	Graham	Alamance
Mebane Brick Yard	Mebane, N. C.	Mebane	Alamance
Aulander Brick Co.	Aulander, N. C.	Aulander	Bertie
Duckworth Brick Co.	Morganton, N. C.	Morganton	Burke
Cherokee Brick Co.	Merry Oaks, N. C.	Brickhaven	Chatham
Carolina Fireproofing Co.	Charlotte, N. C., Box 18	Gulf	Chatham
Clarke Brick & Tile Co.	New Bern, N. C.	Clarks	Craven
Stevenson Brick Co.	5 Craven St., New Bern	New Bern	Craven
Ideal Brick Co. (B. L. Langdon)	Slocomb, N. C.	Slocomb	Cumberland
L. A. Smith & Son	Denton, N. C.	Denton	Davidson
Cunningham Brick Co. (Shale Brick)	Thomasville, N. C.	Thomasville	Davidson
R. W. Hedgecock	Winston-Salem, N. C., R-7	Bethania	Forsyth
Hedgecock & Hine	14th St., Winston-Salem, N. C.	Winston-Salem	Forsyth
Kendrick Brick & Tile Co.	Mt. Holly, N. C.	Mt. Holly	Gaston
Pomona Terra-Cotta Co.	Pomona, N. C.	Pomona	Guilford
House Brick Co.	Scotland Neck, N. C.	Scotland Neck	Halifax
Sherrel Brick Co.	Fletcher, N. C.	Fletcher	Henderson
The Moland-Drysdale Corp.	Hendersonville, N. C.	Etowah	Henderson
Fletcher Brick Works	Fletcher, N. C.	Fletcher	Henderson
Statesville Brick Co.	Statesville, N. C.	Statesville	Iredell
Selma Brick Co.	Raleigh, N. C.	Selma	Johnston
Sanders & Beasley	Smithfield, N. C.	Smithfield	Johnston
L. C. Isenhour	Colon, N. C.	Colon	Lee
Sanford Brick & Tile Co.	Sanford, N. C.	Sanford	Lee
Moseley Brick & Shingle Co., Inc.	Kinston, N. C.	Kinston	Lenoir
Faison Brick Co.	Rocky Mount, N. C.	Rocky Mount	Nash
Dail Brick Works	Greenville, N. C.	Greenville	Pitt
J. M. Hopper Construction Co.	Leaksville, N. C.	Leaksville	Rockingham
Bostic Brick Co.	Lattimore, N. C.	Bostic	Rutherford
Yadkin Brick Yards	New London, N. C., Rt. 2	New London	Stanly
Carolina Shale Brick Co.	Box 18, Charlotte, N. C.	Norwood	Stanly
Pine Hall Brick Co.	Winston-Salem, N. C.	Walnut Cove	Stokes
M. A. Walker & Co.	Winston-Salem, N. C.	Walnut Cove	Stokes
Hedgecock Brick Co.	Walnut Cove, N. C.	Walnut Cove	Stokes
Seaboard Shale Br. & Tile Co.	Box 18, Charlotte, N. C.	Shaleton	Union
Gordon Brick & Tile Co.	Goldsboro, N. C.	Goldsboro	Wayne
		Sanford	Lee
H. Weil & Bros.	Goldsboro, N. C.	Goldsboro, N.	Wayne
Gordon Brick Co.	North Wilkesboro, N. C.	N. Wilkesboro	Wilkes

POTTERY

There has been a steady increase in the development of the pottery industry in North Carolina for the past few years. There is a well developed pottery industry in the State but the production in 1935 was less than that of the previous year. The demand for hand-painted art pottery made in this state has extended far

beyond its borders. Many carloads are shipped each year to the large Northern cities, especially New York, Philadelphia and Washington.

There are plenty of clays in this State suitable for making high grade pottery which are the finer alumina sediments underlying the river terraces found in many of the broader valleys, the better clays being found usually near the shore line of the terraces. Such clays are found underlying the terraces along the Catawba River, north of Morganton and Mt. Holly, Burke County; near Blackburn and Catawba, Catawba County; the south fork of Catawba River, just north of Lincolnton, Lincoln County; the Yadkin River, near Wilkesboro, Wilkes County; Elkin, Surry County; including the old terraces of the Deep River, near Ulah and Whynot, Randolph County; in Buncombe and Henderson counties along the French Broad River. In the eastern part of the State along the Cape Fear River, near Fayetteville, Cumberland County; the Neuse River near Goldsboro, Wayne County; and Contentnea River, a tributary of the Neuse, in Wilson County, near Wilson, are similar deposits of clay.

LIST OF POTTERY PRODUCERS IN NORTH CAROLINA FROM 1929 TO 1935, INCLUSIVE

Name of Company or Producer	Address	Plant Location	
		Town	County
Brown Brothers Pottery Company	Arden	Arden	Buncombe
Pisgah Forest Pottery	Brevard Road, Arden	Arden	Buncombe
Omar Khayyam Pottery	Candler	Candler	Buncombe
Reems Creek Pottery Company	Weaverville	Weaverville	Buncombe
William Penland Pottery	Candler	Candler	Buncombe
Hilton Pottery Company	Hickory, Route 1	Hickory	Catawba
Log Cabin Pottery	Guilford College	Guilford	Guilford
The Jugtown Pottery	Steeds	Backwoods	Moore
North State Pottery Company	Sanford	Sanford	Lee
Kennedy Pottery	Wilkesboro	Wilkesboro	Wilkes

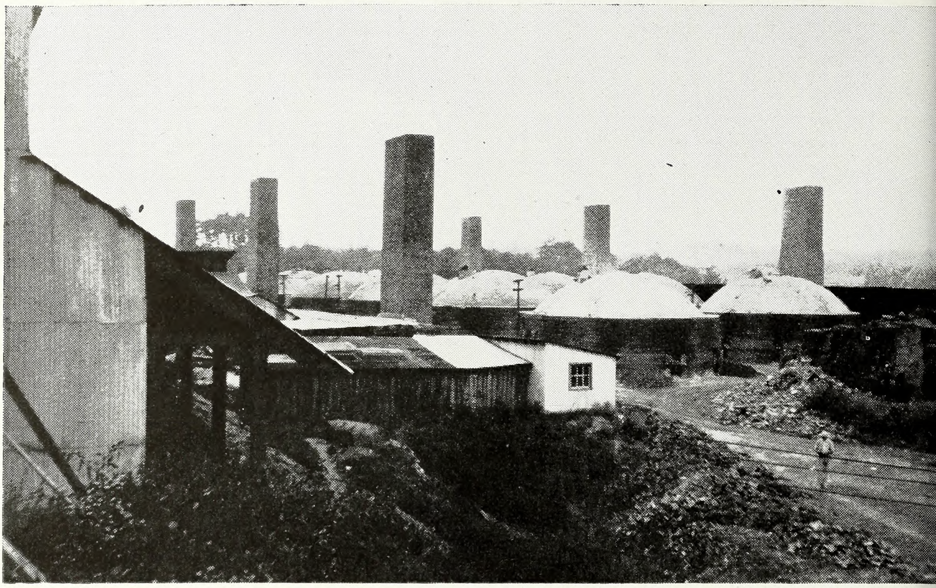


Fig. 11. Brick Plant, Stanly County

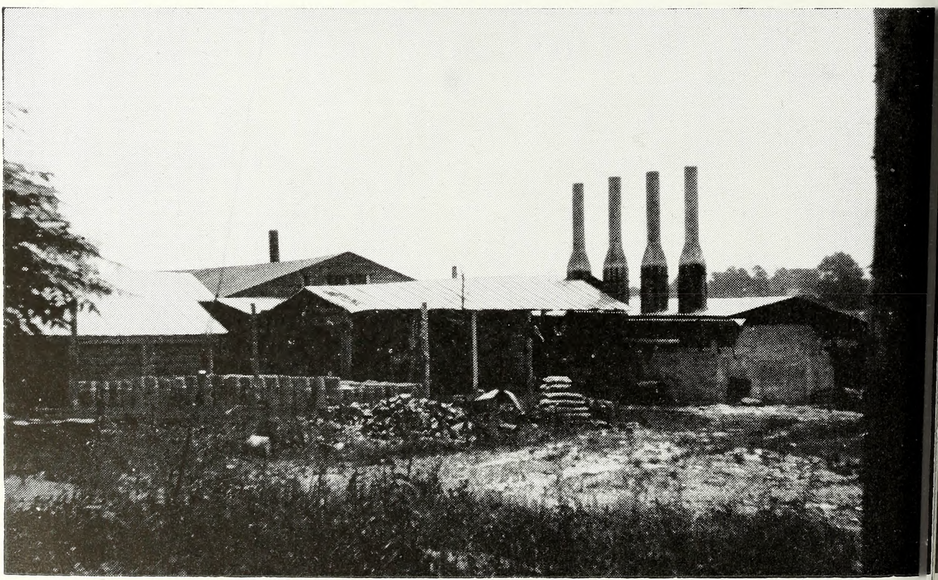


Fig 12. Pottery Plant, Matthews, Mecklenburg County

COAL

On account of the location of the Deep River Coal Field, several companies have been investigating the possibilities for further development. Since there is a differential of $2 to $3 per ton in freight rates, within a radius of a hundred miles of the field, these deposits may be developed in the near future to supply the local demands.

The several attempts in the past years to develop this field on a large scale have not been successful on account of explosions, inadequate finances, and on account of the nature and conditions in the field. Several explosions have occurred because the companies did not rock-dust the mine. The coal has a high per cent of low temperature volatiles, therefore the fine coal dust is rather explosive, and unless rock-dusting or sprinkling is used, explosions will continue to occur as long as mining is undertaken.

The several companies which have attempted to develop the field have had limited capital and have never been in a position to develop the mine on such a scale and under such conditions as to be a commercial success. If the company is adequately financed and is able to employ the best mining methods in the coal mining industry, it should be a successful operation.

On account of basic igneous dikes cutting the coal seams and in some instances on account of the small faults that are encountered, the cost of production per man-ton is considerably higher in this field than in ordinary coal fields. However, since the freight differential is decidedly in favor of this field, a higher price per ton can be obtained for the coal produced.

Within the past few years, tests have been made at several places within the State and outside of the State to determine the value of the coal in pulverized form. The tests so far conducted have proved quite satisfactory, and the coal ranks high compared with other coals in pulverized form.

The parting or black band in the coal vein, and the black shale or "chert," lying immediately above and below the coal, have possible commercial value as a fertilizer filler since it contains varying percentages of nitrogen and phosphorous. The nitrogen is in the form of ammonia and ammonium sulphate. The phosphorous is in the form of calcium phosphate. In addition to the nitrogen and phosphorous contained in the shales,

which may be of fertilizer value, the shale also contains an average of about thirty gallons of oil per ton.

Two or three chemical companies have offered from $3 to $4 per ton, f.o.b. car, for the black band or "chert" associated with the coal. Little or no information is available relative to the materials contained in the shale that may be of commercial value.

The reports covering the Deep River Coal Field show a tonnage of approximately seventy million which may be recovered with modern mining practices. The field has been rather completely core-drilled, in all about fifty core-drill holes have been sunk.

Below is a table showing production of coal from the Deep River Coal Field from 1929 to 1935, inclusive:

COAL PRODUCTION IN NORTH CAROLINA
FROM 1929 TO 1935, INCLUSIVE

Year	Quantity	Value	Average Per Ton
1929	58,180	$177,000	$3.39
1930	28,500	100,000	3.51
1931	2,363	9,000	3.81
1932	1,900	6,000	3.16
1933	2,014	7,000	3.48
1934	3,140	9,000	2.86
1935	2,000*	4,500	2.25

*Estimated.

The table below gives a list of the coal producers which have operated in North Carolina during the period 1929 to 1935. At the present time only one company is producing coal. Plans are underway, however, by other companies to develop the field on a large scale.

PRODUCERS OF COAL IN NORTH CAROLINA
FROM 1929 TO 1935, INCLUSIVE

Name of Company	Address	Mine Location	
		Town	County
N. C. Coal Mining Corporation	Sanford	Carbonton	Moore
Ralph Jordan and R. G. John	Sanford	Gulf	Moore
Southern Anthracite Corporation	Sanford	Sanford	Moore
Anthracite Mining Company	Sanford	Carbonton	Moore
Stokesbury Coal Mining Company	Winston-Salem	Walnut Cove	Stokes
W. H. Davis	Walnut Cove	Walnut Cove	Stokes

KYANITE

KYANITE DEPOSITS IN NORTH CAROLINA

By JASPER L. STUCKEY

INTRODUCTION

Kyanite is widely distributed throughout the Piedmont Plateau and Appalachian Mountain sections of North Carolina (Fig. 13). The most important deposits are found in a belt some 6 to 8 miles wide which extends along the line of the Black and Great Craggy Mountains from the vicinity of Burnsville, Yancey County to Swannanoa, Buncombe County. Smaller but interesting deposits occur to the north and south of the main area and in widely separated sections of the Piedmont Plateau.

Numerous references to kyanite in North Carolina have appeared in the literature, but few of them contain geologic accounts of its occurrence. The more important geologic papers are those by Kunz, Keith, and Keith and Sterrett, in which brief accounts of the associated minerals and inclosing rocks are given.

The author has recently had the opportunity of examining a number of deposits in widely separated areas of the State, and representative types from three localities are discussed here. These are: (1) a deposit five miles west of Smithfield, Johnston County; (2) a group of occurrences in the Burnsville-Swannanoa area; and (3) a deposit near Sioux, Yancey County.

GEOLOGIC OCCURRENCE OF KYANITE

Rock Formations: All the known occurrences of kyanite in North Carolina are found in highly metamorphosed acid rocks

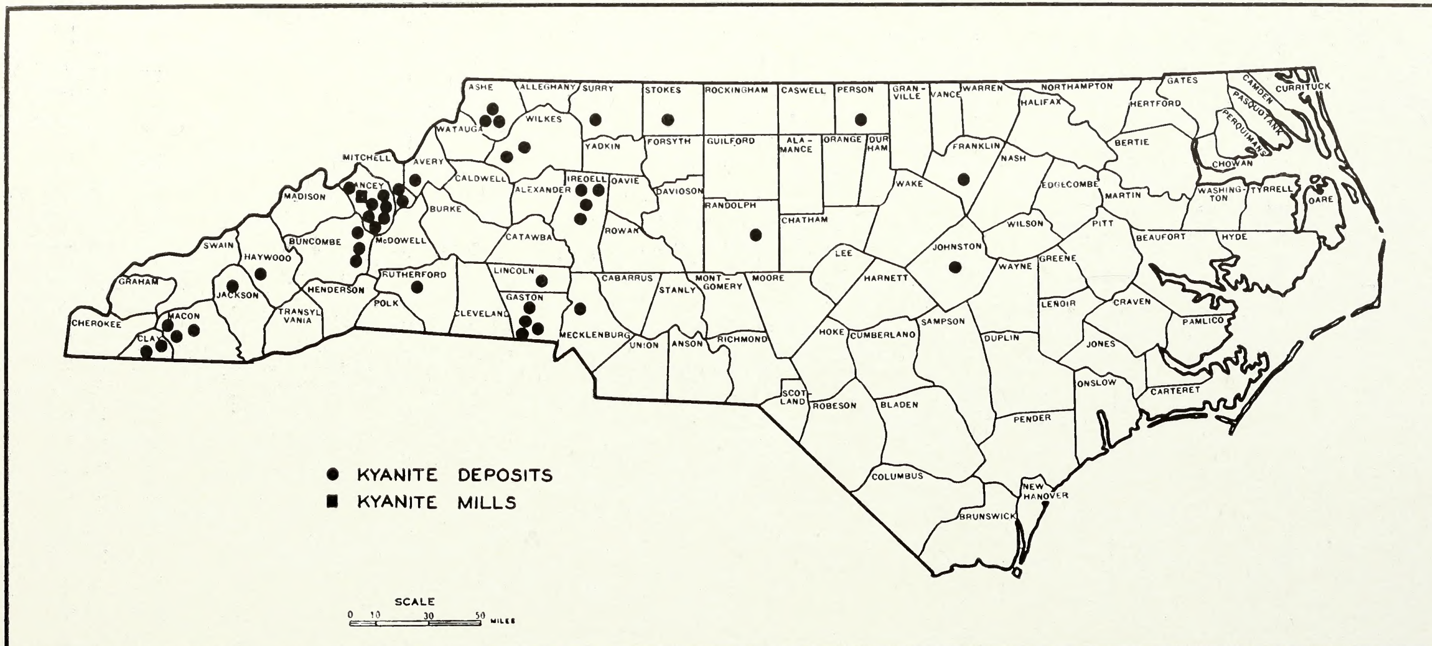


FIG. 13. MAP SHOWING LOCATION OF KYANITE DEPOSITS AND KYANITE CONCENTRATION PLANTS

or in pegmatite dikes and quartz veins inclosed in these rocks. The crystalline rocks of the State may be briefly summarized as follows:

1. Archaean—Gneisses, schists and schistose granites:
   a. Carolina gneiss, b. Roan gneiss, c. Intrusive granites.
2. Algonkian—Schistose volcanics and slates.
3. Cambrian—Slates, schists and quartzites.
4. Post-Cambrian Intrusives—Granite, pegmatite, diorite, gabbro. Also quartz veins.

Kyanite is associated with all of the first three divisions except the Roan gneiss and with many of the pegmatite dikes and quartz veins of the fourth.

The Carolina gneiss is composed of a great series of interbedded gneisses and schists, chiefly composed of quartz, varying amounts of acid feldspar and either muscovite or biotite or both. At times either garnet or kyanite may be dominant minerals in the gneiss or schist and give it the name. The rocks are light or dark gray in color, have a fine grain, marked schistosity and, except for the larger crystals of kyanite and garnet, an even texture. The original nature of this formation is in doubt but it probably consisted of igneous and sedimentary rocks.

The "granites" of Archean age consist of schistose granite of varying coarseness and color and of schist and granitoid gneiss derived from granite. Included in the granite rocks are local lenses of Carolina and Roan gneiss. Kyanite is occasionally found in areas of this type of granite.

The Algonkian rocks of the middle and lower Piedmont Plateau consist of a great series of schistose volcanics and slate. This series is composed of ash and tuff of rhyolitic and dacitic composition, volcanic breccia of rhyolitic and andesitic composition, flows of rhyolite and andesite and beds of shale all of which have been metamorphosed into schistose and slate-like rocks. Some of the altered rhyolitic masses and siliceous tuffs contain interesting deposits of kyanite.

The Cambrian metamorphosed sediments form scattered belts and irregular areas in the upper Piedmont Plateau and Mountain sections of the State. In their present condition these formations are largely schist, slate and quartzite, and some of them,

particularly the Brevard schist along the western edge of McDowell and the eastern edge of Buncombe counties, contain varying amounts of kyanite.

Occurrence: In all the deposits examined the kyanite occurs in acid gneisses or schists, either as disseminations or as rounded masses or lenses associated with quartz vein and pegmatite dikes. It has not been observed in an unaltered granite or associated with a basic rock such as hornblende gneiss or schist, andesite, diorite, or gabbro.

While one might give an elaborate classification of the kyanite deposits, it would seem sufficient for the present discussion to make two groups as follows: (1) disseminated deposits of kyanite forming irregular lenses in schistose rocks, and (2) pocket or bunchy deposits of kyanite occurring as lenses in pegmatite dikes or quartz veins. A more detailed classification than this has been attempted by some.

Characteristics: The deseminated deposits are widely distributed in acid metamorphic rocks of Archean, Algonkian, and Cambrian age, and the pocket or bunchy deposits are confined to quartz veins and pegmatite dikes that are associated with and occur in rocks of the same age.

The metamorphic rocks have a well defined cleavage that strikes 30° N. 50° E. and dips steeply, at some places to the northwest and at others to the southeast. The quartz veins and pegmatite dikes generally follow the cleavage of the inclosing rocks.

The kyanite crystals in the disseminated deposits vary in length from a fraction of an inch to 3 or 4 inches but average less than an inch. On weathered surfaces they often stand out in relief giving the rock a porphyritic appearance. They vary in color from blue through gray to colorless. These crystals are usually parallel to the cleavage of the inclosing rocks, but may cut across schistosity. In the pocket or bunchy deposits in the quartz veins and pegmatite dikes the crystals range up to 6 or 8 inches in length and lie in every position. They are deep blue in the center of the blades and gray or colorless along the edges.

Examples of Disseminated Deposits: An interesting deposit of this type is located about five miles west of Smithfield, Johnston County, near the eastern limit of the crystalline area. The

bedrock of the region consists of acid schistose volcanics and slates of Algonkian age which have been strongly silicified. The kyanite occurs in a rock that ranges from almost pure quartzite to quartz mica schist. This rock contains veins and lenses of massive white quartz from a few inches to 5 or 6 feet wide which conform to the northeast strike of the rock clevage. Kyanite associated with pyrophyllite occurs irregularly disseminated through these rocks in lense-like masses that vary from almost pure kyanite to barren rock. The kyanite crystals are light gray to colorless, have a maximum length of 2 inches, and lie in every position.

In the Burnsville-Swannanoa area and its extension in Mitchell County, kyanite occurs abundantly disseminated as irregular lenses in the Carolina gneiss. These lenses vary greatly in size, ranging from a few feet wide and 100 to 200 feet long to one-quarter mile wide and one-half or more in length. The lenses are aligned with the strike of the inclosing rocks and pass by gradations from portions rich in kyanite to barren country rock. Not only are they generally lenticular in outline as followed along the surface of the ground, but they also have a vertical lenticular structure. The large lenses are commonly composed of a series of smaller lenses or bands which are rich in kyanite. Small kyanite-bearing quartz veins and pegmatite dikes from a few inches to 3 or 4 feet wide cut the larger lenses.

Deposits of disseminated kyanite are also found in areas mapped as granite. At Sioux on Cane River, sixteen miles northwest of Burnsville, there is such a deposit in rocks mapped as Cranberry granite. These rocks are highly metamorphosed granite, with which are infolded small masses of Carolina and Roan gneiss. The Kyanite body occurs at such an infold. The deposit is lenticular in outline with its greatest elongation in a northwest direction, across the cleavage of the country rock. The deposit has an internal lenticular structure, consisting of lenses rich in kyanite along with barren rock. The small internal lenticular structure conforms to the strike of the country rock. Small masses of quartz and pegmatite materials are scattered through the deposit.

Pocket or Bunchy Deposits: Kyanite deposits of this type are abundantly distributed through the Carolina gneiss of the Burnsville-Swannanoa area and its extension in the mountain

province of the State. They consist of small lenses from 3 to 8 feet wide and 10 to 100 feet long, associated with pegmatite dikes and quartz veins. In some lenses, kyanite occurs in crystallized pegmatitic material consisting of quartz, orthoclase, albite, and mica, in others it is associated with fine-grained pegmatitic material composed of intermixed granular quartz and feldspar and small sheets of mica, or in massive white vein quartz. These three variations pass by gradations from one to another, and doubtless represent stages in pegmatite formation.

Deposits of this type are small and discontinuous, but intermittent outcrops may be traced along the same line of strike for 2 or 3 miles. An interesting group of lenses of this type occurs along the edge of Burns Mountain about one-half mile east of Bandana, Mitchell County, where lenses of pegmatite dikes and quartz veins from 5 to 10 feet wide may be traced for a mile or more. Most of the lenses contain more or less kyanite and some of them are masses of almost pure kyanite. The schistose rocks surrounding each lens are commonly kyanite-bearing, with a much greater concentration of kyanite near the pegmatite or quartz vein than a few feet away. Near one outcrop of this type is a shaft 36 feet deep in which are exposed four lenses of kyanite-bearing pegmatite. Each lens varies in width from 2 to 3 feet and in vertical length from 3 to 4 feet. Between lenses is a stringer of pegmatite 4 to 6 inches wide.

Mineralogy: The disseminated deposits carry quartz, orthoclase, albite, biotite, muscovite, magnetite, pyrite, and graphite as original minerals, and muscovite, garnet, kyanite, pyrophyllite, sericite, chlorite, and biotite occur as secondary ones. Muscovite of secondary origin occurs as coarsely crystalline flakes and elongated blades associated with garnet and kyanite. Garnet is abundant as crystals one-quarter inch and less in diameter, associated with kyanite and secondary muscovite.

Kyanite varies in color from light blue through gray, white to colorless, has a specific gravity of 3.5 to 3.7, and a hardness of 4 to 5 parallel to the crystals and 6 to 7 across them. It occurs as irregular crystals which vary from a fraction of an inch to 3 or 4 inches long and seldom have well developed crystal ends.

Pyrophyllite is found only in the deposit near Smithfield where it occurs as irregular flakes and needles closely associated with kyanite. The other secondary minerals sericite, chlorite,

and limonite have been developed by weathering processes since the period of kyanite formation, and have no relation to its origin.

The pocket or bunchy deposits found in quartz veins and pegmatite dikes consisted originally of quartz or quartz and orthoclase. Secondary minerals observed in these deposits are albite, biotite, muscovite, garnet, kyanite, tourmaline, corundum, graphite, and sericite. Albite is an important constituent of the pegmatite dikes, where it occurs in granular masses and as well defined grains and fragments up to 3 or 4 inches in diameter.

The kyanite varies in color from deep blue through green, yellow, gray, white or colorless. It occurs as crystals which vary from a fraction of an inch to 8 to 10 inches long.

Corundum of the deep blue variety was seen as crystals one-quarter inch in diameter embedded in large crystals of deep blue kyanite, but was not seen in thin section.

Petrography: A careful study of thin sections cut from the various deposits shows that the kyanite bodies have been formed in (1) quartzite and quartz mica schist associated with altered volcanics; (2) gneisses, schist and granitoid bands; and (3) pegmatite dikes and quartz veins.

At the deposit five miles west of Smithfield, the quartzite and quartz mica schist contain as original minerals quartz and muscovite. The first important change seems to have been the development of quartz veins, followed by the development of kyanite through the replacement of quartz. Kyanite was not observed in contact with muscovite in thin sections from this deposit, but every section studied shows kyanite replacing the quartz. Following the kyanite, small amounts of pyrophyllite were developed in part by replacement of quartz, and in part by replacement by kyanite.

The rocks, in which the kyanite of the upper Piedmont Plateau and Mountain sections of the State is found, consist essentially of mica gneiss and mica schist. These rocks are composed chiefly of quartz, muscovite, biotite, orthoclase, albite, and occasionally small amounts of magnetite and pyrite. Sections cut from lenses of kyanite-bearing gneiss and schist contain as secondary or later minerals muscovite, garnet, kyanite, sericite, and limonite. The minerals muscovite, garnet, and kyanite are

closely related and apparently have been formed by replacement of the older minerals. Muscovite seems to have been formed first, as it has replaced the older minerals and in turn has been replaced by garnet and kyanite. Garnet and kyanite both have replaced the original minerals of the gneiss and schist and the muscovite, but their relations to each other were not definitely determined; however, crystals of kyanite were observed containing fragments of quartz, biotite, muscovite, and garnet. Sections cut from different parts of the kyanite bodies show every gradation from mica gneiss and schist to practically pure kyanite. Small amounts of sericite were observed associated with feldspar and kyanite, and some chlorite and limonite were seen in several sections. The minerals sericite, chlorite, and limonite were doubtless formed by later weathering.

The quartz veins consist essentially of massive quartz partly replaced by muscovite and kyanite. The muscovite was seen only in small amounts, but had doubtless preceded the kyanite. In one or two cases small particles of graphite were observed embedded in quartz as well as deposited along fractures and openings.

The pegmatite dikes contain quartz, orthoclase, albite, muscovite, kyanite, and locally tourmaline, garnet, biotite, and varying amounts of rare minerals. Albite has apparently replaced orthoclase followed by the development of muscovite and garnet. Tourmaline has replaced quartz and the feldspars, but was not seen in contact with muscovite and garnet. The relations of the biotite and the rare minerals were not determined. The kyanite, however, has replaced quartz, feldspar, muscovite, and tourmaline indiscriminately. Graphite, in small amounts, was observed embedded in quartz, feldspar, and kyanite, and distributed along the cracks and cleavage planes in these minerals and in the schistose wall rocks of the deposits. This indicates that graphite was deposited during the entire period of pegmatite formation but no information was obtained as to its source. Small amounts of sericite were also observed associated with the kyanite and feldspar in a few sections. It may have been formed by hydrothermal action, but since many of the feldspars are much weathered it is probably the product of later alteration.

ORIGIN OF KYANITE (Cyanite)

In considering the origin of kyanite the relations of the mineral bodies to the inclosing rocks, their shape and distribution, their mineral-composition, and the relation of the constitutent minerals to each other have been taken into account. Developments of the deposits may furnish additional information that may call for other explanations, but those set down here seem to best fit the present available facts.

Earlier Theories: Kyanite is commonly classed as a mineral peculiar to metamorphic rocks, such as gneisses and schists, especially paragonite schist. Phillips states that it is produced by metamorphic agents and is never found as a pyrogenetic mineral in igneous rocks. Emmons and Lindgren mention the occasional presence of kyanite in contact-metamorphic deposits, but Lindgren omits the reference in his third edition. Clarke classes kyanite as a mineral of metamorphic rocks and states that we do not know the conditions under which it forms, but that temperature and pressure must be taken into account, and suggests that kyanite forms under great pressure. He also states that "it is often embedded in quartz and has been reported in limestones." Dana, Pirsson, Ladoo and Kraus and Hunt all classed kyanite as characteristic of such metamorphic rocks as gneisses and schists. Winchell states that it occurs only in schists and in pegmatites cutting schists. Ries mentions the occurence of kyanite in quartzite of Cambrian age in Virginia, and Bayley states that in Georgia it is "an important constituent of crystalline schists that are metamorphosed Cambrian sediments and on the sides of quarts veins cutting them". Fessler and McCaughey attribute the origin of kyanite in Western North Carolina to the assimilation of the country rock by pegmatites or to the pneumatolytic action of the pegmatites on the country rock.

Origin of North Carolina Kyanite: The field and microscopic evidence indicates that the kyanite deposits have been formed by metasomatic replacement of acid crystalline rocks, pegmatite dikes and quartz veins. Evidence that the kyanite has been formed by replacement is as follows: (1) gradational contacts between the kyanite bodies and the country rock; (2) internal lenticular structure of the kyanite bodies in which layers and lenses of kyanite are associated with masses and lenses of the

country rock containing little or no kyanite; (3) the development of kyanite in widely differing rocks such as (a) schistose quartzite and quartz mica schist, (b) gneisses and schists, and (c) pegmatite dikes and quartz veins; and (4) microscopic evidence of replacement.

In the quartzite and in the quartz mica schist, kyanite occurs as long needle-like or bladed crystals with pointed or blunt ends. These crystals may penetrate the larger quartz grains or may cross two or three smaller ones. The kyanite in the gneisses and schist occurs as stubby crystals which usually lie parallel to the other minerals. However, these crystals often replace the older minerals and also contain fragments of them. In the quartz veins of crystals of kyanite penetrate or cut across quartz grains in every position. The kyanite crystals in the pegmatite dikes are usually bladed individuals with irregular ends that replace the older minerals indiscriminately.

The following order of events is deduced:

1. Metamorphism of the original rocks to quartzite, gneisses, and schists.

2. A period of igneous activtiy during which the pegmatite dikes and quartz veins were formed.

3. Development of albite in the pegmatites followed by the formation of muscovite, biotite, tourmaline, garnet, and kyanite by replacement of the older minerals in both pegmatite dikes and quartz veins.

4. Development of (a) muscovite, (b) garnet, and (c) kyanite by replacement of older minerals in the schistose rocks.

5. Development of graphite during the period of kyanite formation as indicated by its inclusion in quartz, feldspar, and kyanite, and its formation in the cracks and cleavage places of these minerals and in the inclosing schistose rocks.

6. A second period of metamorphism during which the kyanite deposits were mashed and their minerals crushed and folded.

Source of Solution and Condition of Kyanite Formation: The foregoing descriptions of the occurrence, distribution and petrogrphy of the kyanite deposits seem to indicate that they were formed by heated solutions acting in well defined local areas, and not by dynamic metamorphic processes.

The schistose volcanics and slates, and gneisses and schists of the eastern part of the Piedmont Plateau have been intruded in places by igneous rocks. These rocks furnished hot solutions which locally developed in the schistose country rock mineral deposits such as gold, copper, and pyrophyllite. A comparison of the kyanite deposit five miles west of Smithfield with the pyrophyllite deposits in the same group of rocks indicates that it belongs to the earlier stages in the same period of mineralization that formed the pyrophyllite. No igneous rocks were seen near the kyanite deposit but the indications are that it was formed by heated waters of igenous origin.

The origin of the kyanite deposits in the upper Piedmont Plateau and Mountain sections of the State seems to be related to the pegmatite dikes of the region. Pegmatites are commonly considered as the end product of granite formation. Lindgren suggests that the probable relations seem to be:—granite grades into pegmatite dikes, these change to pegmatite quartz, and this into veins which often contain quartz and metallic ores. This gradation suggests that pegmatites may vary from consolidated magma to purely aqueous deposits.

The pegmatite dikes of this region are of two types. The first type consists of a group varying from 10 to 50 or more feet in width and composed chiefly of quartz, potash feldspar, and small amounts of muscovite mica, and other minerals. Pegmatites of this type are extensively worked for feldspar. Very few rare minerals are found in the feldspar mines and not a single deposit is known to contain kyanite. The second type consists of a group varying from a few inches to 8 to 15 feet in width and composed of a wide variety of minerals. This type contains quartz, feldspar, and mica with such minerals as beryl, emerald, tourmaline, garnet, and columbite, as well as lenses and areas rich in kyanite.

The first type probably represents a group of dikes which have consolidated from magmas, but the writer holds with Keith that the smaller dikes "appear to have been formed by deposition from mineralized waters after the manner of veins."

Keith classes the muscovite, garnet, and kyanite in the gneisses and schists as secondary minerals, and believes that the pegmatites were formed between two great periods of metamorphism. Field and microscopic evidence gathered in the

present investigation indicates that the kyanite, in the pegmatites and in the gneisses and schists, is of the same age and has undergone the same amount of metamorphism.

Hess, Landes, and Schaller have all recently pointed out that pegmatite formation often involves a long series of replacements. Schaller in a discussion of the California pegmatites holds that the development of pegmatite involves an original injection of quartz orthoclase magma followed by a series of high temperature replacements. He points out the following order: albite, muscovite, tourmaline, garnet, and lithium minerals.

It is believed that the kyanite in lenses in pegmatite dikes, quartz veins, and adjoining gneisses and schists was formed by residual solutions accompanying the pegmatite formation. The kyanite in the pegmatite dikes and associated quartz veins was formed as one of the series of pegmatite replacements, while that in the gneisses and schists was probably formed by the metasomatic replacement of these rocks by solutions given off by the pegmatite dikes and their parent magmas. It seems probable that the kyanite was formed under conditions of high temperature.

Age of Kyanite: In the Kings Mountain district the pegmatites seem to be genetically connected with the Whiteside granite, which is of late Carboniferous age. The exact source and age of the pegmatites associated with the kyanite-bearing schist in the Burnsville-Swannanoa area is unknown, but in areas farther southwest pegmatites have been developed in connection with the Whiteside granite, which is intrusive into the gneiss. Practically all the pegmatites are alike in shape and structure and apparently have suffered the same amount of metamorphism. This, together with the fact that some of the pegmatites are known to be of Carboniferous age, indicates that age for all the pegmatites and the associated kyanite.

The three minerals andalusite, sillimanite, and kyanite first became of interest in 1917 when the U. S. Bureau of Standards was given the problem of developing a better spark plug core which could be used for airplane motors. These three minerals are of the same chemical composition, aluminum silicates ($Al^2O^3.SiO^2$), but are quite different in appearance, crystal structure and physical properties. They have long been of interest to mineralogists, but only in recent years have they been considered of commercial value.

Sillimanite was first used in the experimental work for spark plug cores. On account of the scarcity of the natural mineral, synthetic sillimanite was prepared by calcining clay and artificial alumina. The synthetic sillimanite was incorporated into porcelain bodies in quantities larger than it would have been possible to develop from the clay contained in the bodies. This mineral was used as a substitute for other minerals, especially quartz or potter's flint.

The tests showed that the spark plug core resisted heat shock much better than other cores. After these tests on spark plug cores, other refractories, as fire brick, were made from sillimanite bonded with clay, which proved very satisfactory. They outlasted all other types of fire brick.

The successful use of the synthetic sillimanite caused the manufacturers to look for the natural mineral. Mineralogical literature was searched for every possible lead. During the systematic prospecting a deposit of andalusite was located in California. This deposit is controlled by the Champion Porcelain Company and is said to be the only commercial deposit of andalusite so far known. The natural sillimanite is even more scarce than the andalusite; however, in 1932 and 1933 Mr. Philip S. Hoyt, Franklin, N. C., shipped several carloads of natural sillimanite from Clay County, N. C. Mr. Hoyt said that this was the first shipment of sillimanite from any point in the United States.

After sillimanite and andalusite proved so successful in refractory products where sudden changes in temperature are necessary, tests were then conducted on high-grade kyanite crystals to determine its utility in similar refractory products. It was soon found, however, that kyanite could not be used as sillimanite and andalusite, on account of its high coefficient of expansion when heated. When heated or calcined to cone 12 or 13 (2390° to 2465° F.), the original specific gravity drops from 3.6 to 3.1, and a mixture of mullite and glass is formed. The calcined material is very friable and more difficult to bond than raw andalusite. Since kyanite, however, can be used satisfactorily in certain products, several companies became interested in the North Carolina kyanite deposits.

However, only one recovery plant has been erected to produce a kyanite concentrate. The kyanite recovery plant was erected by the Celo Mines, Incorporated, and is located four miles south

of Burnsville in Yancey County. The plant is located near the top of the mountain, and the ore is a kyanite schist carrying from 10 to 20 per cent kyanite. The plant consisted, at first, of crusher, screens, conveyors, and an electromagnetic and electrostatic machines. Later the electrostatic separators for cleaning the concentrates were replaced by dry tables, and a swing hammer mill was substituted for the rod mill. A rotary kiln is used to calcine the kyanite. A very high-grade product is produced at this plant. The price of the kyanite varies with the purity.

The only producer of kyanite is the Celo Mines, Incorporated, Burnsville, North Carolina.

Many of the uses are questionable but there is a possible use in a great many different ceramic bodies, especially in the refractory materials. Experiments and tests have been carried on with kyanite to determine its value in the following materials: spark plugs, refractory brick, porcelain ware, both the china and electrical; sagger clays; in glass manufacture to add toughness; and it is especially suitable for chemical ware.

Concentration tests on the kyanite ores from North Carolina were made at the Southern Experiment Station of the Bureau of Mines. The results of these concentration tests were quite satisfactory. Classification and tabling were made to yield a fair recovery of a 90 per cent concentrate, but higher grades require flotation. Flotation also increases the total recovery. The problem of utilizing the kyanite schist is not simply to free the kyanite and separate it from the adhering impurities, as the final product for most refractory uses must have a suitable size ratio, containing grains as coarse as 4-mesh. Different types of kyanite crystals behave differently when heated. It is found that certain bladed varieties change to a weak, chalky form when converted to mullite, whereas certain fibrous or more massive types do not. Some consideration was given the possibility of sintering or nodulizing the finer concentrates. V. L. Mattson, head of Celo Mines, Incorporated, Burnsville, North Carolina, found that the puffing of kyanite grains on inversion into mullite is a function of grain size and is much less noticeable with the fines.

The Laclede Christy Clay Products Company, of St. Louis, manufactures a cellular brick of about 50 per cent kyanite con-

tent, which combines the function of a refractory, a heat insulator, and a light weight building unit. Its principal use is for furnace roofs.

The price of kyanite ranges from $10 a ton for impure dornick ores to $25, and in some instances to $36, for high-grade concentration f.o.b. mines.

No figures are available for production of kyanite in North Carolina, but it is believed that between four and five thousand tons are produced from American mines annually. The production is principally from North Carolina, Georgia, and California. About 1,000 tons are imported annually.

BROMINE

Probably the most outstanding development in the mineral industry in North Carolina during the past few years was the construction of a plant for the extraction of bromine from sea water. The plant was constructed by the Ethyl-Dow Chemical Company at Kure Beach south of Wilmington.

Before the construction of the plant, a boat trip was made along the eastern coast of the United States, during which several samples of sea water were taken for the purpose of determining the bromine content of the water. It was found that the bromine content was rather uniform throughout the entire area traversed by the boat. The samples of water taken showed from 65 to 70 parts per million bromine. On account of the low bromine content, a great deal of water has to pass through the plant daily. Therefore, in picking out a location for the extraction plan it was found that the beach south of Wilmington was the most favorable location along the Atlantic Seaboard.

Since all of the water emptied by rivers into the ocean along the eastern seaboard moves in a southerly direction, it was found necessary to locate the plant on the north shore of one of the rivers, close to the point where it entered the Atlantic Ocean. The long narrow promontory north of the Cape Fear River was found to be an ideal location for such a plant. There were no rivers emptying into the Atlantic immediately to the north of this location. Also, the water from which the bromine had been extracted could be emptied into the Cape Fear River. Since the Cape Fear discharges into the Atlantic several miles

to the southeast, and since the water from this river flows southward, there is no danger of lowering the bromine content of the water on the intake side of the beach.

Before the erection of the commercial plant, a small test plant of 500 pounds of bromine per day was erected. Since the test plant was a success, construction was soon started on the large commercial plant. The plant was completed in 1933.

"The extraction of bromine from sea water takes place in two identical units. Each unit consists chiefly of a blowing-out tower in which a current of air removes the bromine from acidified and oxidized water, and an adjacent absorption tower in which the bromine is extracted from the air by means of a soda ash solution. . . . After the bromine from the sea water has been collected in the form of a solution of sodium bromide and bromate, the remainder of the process is performed according to methods which have been previously in use in the industry. The bromide-bromate liquor is treated with sulfuric acid to liberate the bromine. The free bromine vapors are then steamed out of the acidified solution and are condensed into pure liquid bromine.

"The bromine is used in the manufacture of ethylene dibromide. Ethylene is made by passing ethyl alcohol vapor over heated kaolin catalyst to form ethylene gas, which is in turn brominated according to the standard method to form pure ethylene dibromide.

"The power house employs hand-fired boilers and makes steam only for heating and evaporating purposes. Its capacity is about 15,000 pounds of steam per hour at a pressure of 150 pounds per square inch. Operating electric power is purchased from the Tidewater Power Company. It is delivered to the plant at 33,000 volts where it is stepped down to 2300 volts in two transformer banks.

"The entire plant is functioning as anticipated and is removing about 15,000 pounds of bromine per day from sea water. This is being converted into ethylene dibromide at an efficiency somewhat over 90 per cent.

"The direct recovery of minerals for industrial use from sea water has long held the attention of chemists, and it is believed that this plant is the first to accomplish this achievement on a commercial scale of operation. The extraction of gold from sea water in which it is present to the extent of but a few parts per

billion has always been the investigator's most fascinating goal, but no success along this line has been reported thus far. Now that the recovery of bromine, which is present to the extent of less than 70 p. p. m., has been successfully executed, it does not seem beyond reason to expect the chemist of the next decade to extract gold from the sea water commercially."*

Tetra-ethyl lead is the active ingredient in "Ethyl Fluid". The antiknock used in 70 per cent of all the gasoline sold at the present time. For every unit of the tetra-ethyl lead there is required ethylene dibromide to act as a scavenger in removing the residue lead from the motor cylinder after each explosion. The ethylene dibromide for this purpose is the sole product of this plant, and is manufactured according to the outline above.†

FELDSPAR

Feldspar is the name assigned to a group of minerals consisting of several species, all silicates of alumina, with one or more of the bases—potash, soda and lime. These species are divided into two groups, the potash feldspar and the lime-soda feldspars. The former group is by far the more abundant in North Carolina. Orthoclase and microcline whose composition is expressed by the formula $K\ Al\ Si^3\ O^8$, are the chief representatives of the first group while albite, with a formula $Na\ Al\ Si^3\ O^8$, is the most important of the second or plagioclase group.

Feldspar is used chiefly as a flux in the manufacture of pottery, electrical porcelain, and some enameled wares. For these materials the spar must be very low in iron and not over 5 to 10 per cent free quartz. It is also used as a flux or binder in emery or carborundum wheels, and to some extent in the manufacture of glass. For the last purpose it can carry 25 per cent of free quartz. Feldspar possesses advantages over quartz in scouring soap because it is softer and less liable to scratch. The high-grade selected feldspar is used in the manufacture of artificial teeth. It has been suggested that feldspar can be used as a fertilizer because of its high potash content but no commercial practicable means of extraction has as yet been found.

* "Commercial Extraction of Bromine from Sea Water," by Leroy C. Stewart.

†Letter from C. M. Shigley, Manager.

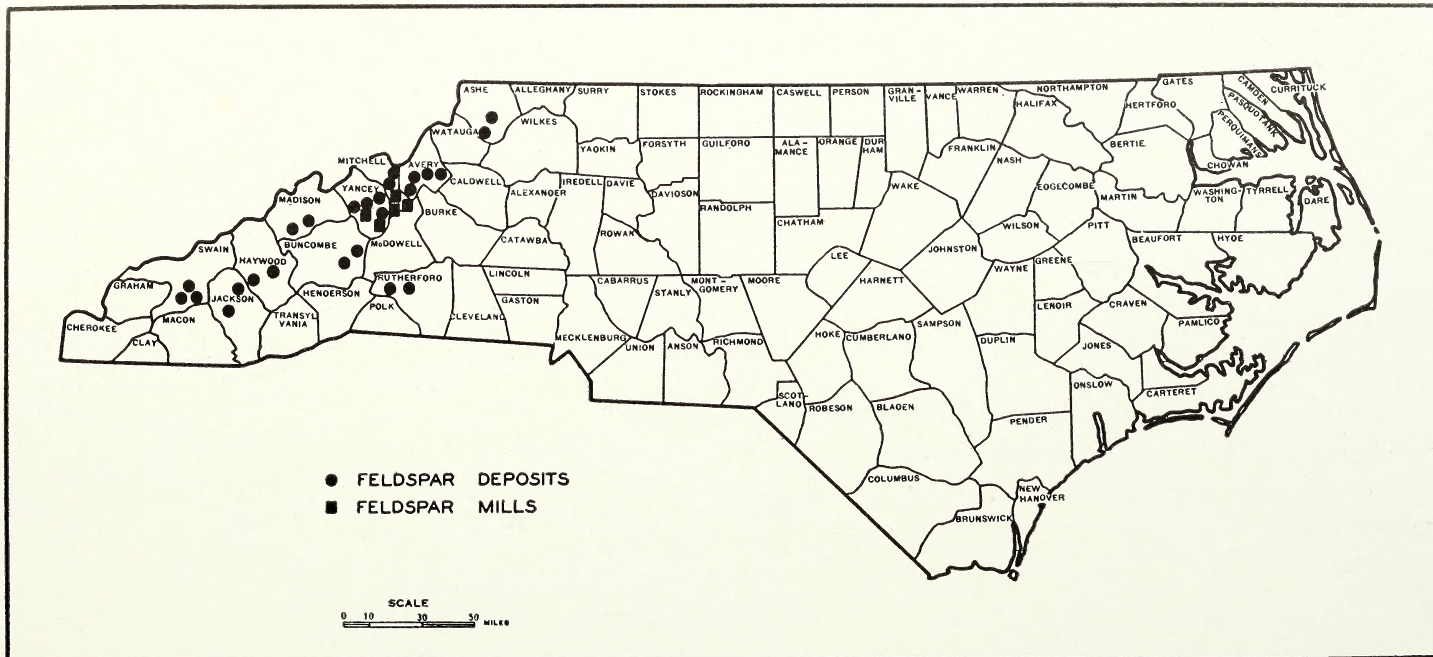


Fig. 14. Map Showing Location of Principal Feldspar Deposits and Feldspar Grinding Plants

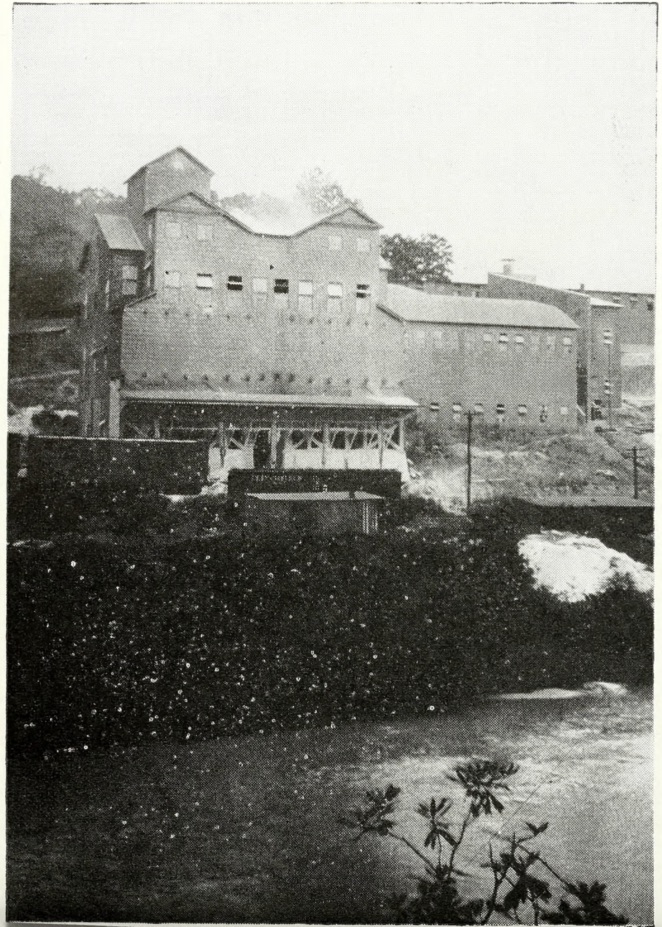
Feldspar occurs in pegmatite dikes. These dikes are known in more than 20 counties in the State confined principally to the mountain district. The pegmatite belt is almost 100 miles wide and extends in a northeast-southwest direction paralleling the Blue Ridge Mountains.

The main feldspar belt may be divided into three smaller belts as follows: The Cowee-Black Mountain belt, the Blue Ridge belt and the Piedmont belt. The Cowee-Black Mountain belt which lies to the west of the Blue Ridge Mountains includes parts of Macon, Jackson, Transylvania, Haywood, Buncombe, Yancey, Mitchell and Avery Counties, has produced all of the feldspar mined in this State. The chief producing district, of which Spruce Pine is the center, is confined to the last three named counties. This district is about 40 miles long and 14 miles wide and is the most promising district of the South.

On account of the large production of feldspar in North Carolina, the most accessible deposits are becoming depleted, and it is becoming necessary for the producers to look for deposits at greater distances from the shipping centers and grinding plants. As a result of these further investigations, large deposits of feldspar have been discovered during the last few years which show a high-grade product. Avery, Mitchell, and Yancey counties have been the leading producing counties of the State, but other counties, as Madison, Rutherford, Swain, Jackson, and Macon, have shown production in recent years. Probably the most important developments in the feldspar industry within the past few years have been accomplished by the Hipps Feldspar Company in Madison County, by McKinney and Henline in Rutherford County, and by the Brooks Feldspar Company in Swain County. The deposits investigated by these companies show a large tonnage of high-grade material, and the future production from these counties will be large.

Production

During the period from 1929 to 1935 there were thirty-two producers of feldspar in North Carolina. In addition to the producers of feldspar, there was also some production as a by-product from mica mines. Mitchell County led in total value of production until 1934, but in that year Yancey County surpassed Mitchell County. The total production of crude feldspar in North



Carolina in 1935 was 82,499 tons valued at $482,729. This production is 58 per cent of the total production in the United States.

There is given in the table below the production of feldspar in North Carolina from 1929 to 1935:

PRODUCTION OF CRUDE FELDSPAR IN NORTH CAROLINA FROM 1929 TO 1935, INCLUSIVE

Year	Amount In Tons	Value	Average Price Per Ton
1929	103,273	$598,938	$5.80
1930	103,163	593,552	5.75
1931	86,429	505,525	5.85
1932	58,465	300,877	5.14
1933	85,962	471,312	5.47
1934	79,844	465,214	5.82
1935	82,499	482,729	5.85

As shown by the above table, the average price per ton in 1935 was greater than in 1929. The total value of production in 1932 was the lowest on record since 1921.

PRODUCTION OF GROUND FELDSPAR IN NORTH CAROLINA FROM 1929 TO 1935, INCLUSIVE

Year	Amount In Tons	Value	Average Price Per Ton
1929	105,626	$1,236,206	$11.70
1930	92,714	1,012,915	10.92
1931	70,558	760,080	10.77
1932	59,225	614,936	10.38
1933	63,074	707,667	11.21
1934	67,497	847,835	12.15
1935	78,012	1,043,979	13.38

As shown by the above table the value per ton of feldspar in 1935 is higher than the value per ton in 1929. However, the total value of production in 1929 exceeds the total value of production in 1935. Both the price per ton and total value of production in the State have increased steadily since 1932.

PRODUCERS OF FELDSPAR IN NORTH CAROLINA IN 1935

Name of Company Or Producer	Address	Mine Location	
		Town	County
Barrett Mining Company	Spear	Spear	Avery
Julius Henline	Newland	Frank	Avery
Hipps Feldspar Company	Asheville	Mars Hill (near)	Madison
Tennessee Mineral Products Corp.	Spruce Pine	11 mines	Mitchell
Charles Duncan	Penland	Duncan	Mitchell
Carolina Mineral Company	Erwin, Tenn.	4 mines	Mitchell
J. C. Pittman	Spruce Pine	Penland	Mitchell
Coy Cox	Estatoe	Estatoe	Mitchell
McKinney & Henline	Bakersville	Rutherfordton	Rutherford
Brooks Feldspar Company	Bryson City	Alarka Creek	Swain
Newdale Mica Company	Newdale	Micaville	Yancey
Blue Ridge Mining Company	Burnsville	4 miles	Yancey
North State Feldspar Corp.	Micaville	Goog Rock	Yancey

FELDSPAR GRINDING PLANTS IN NORTH CAROLINA IN 1935

Name of Owner	Address	Location of Plant	County
Golding & Sons Company	Trenton, N. J.	Spruce Pine	Mitchell
Southern Feldspar Company	Toecone	Toecane	Mitchell
Tennessee Mineral Products Co.	Spruce Pine	Penland	Mitchell
North State Feldspar Corp.	Micaville	Micaville	Yancey
Feldspar Milling Company	Burnsville	Bowditch	Yancey

MICA

The mica-producing region in North Carolina consists of a belt of country about 100 miles wide lying in the Mountain and Piedmont sections of the State. The belt is subdivided into three smaller belts: The Cowee-Black Mountain belt; the Blue Ridge belt; and the Piedmont belt.

The most important mica-producing counties are Ashe, Avery, Buncombe, Burke, Catawba, Cleveland, Gaston, Haywood, Jackson, Lincoln, Macon, Mitchell, Person, Stokes, Transylvania, Watauga, Wilkes, Yadkin, and Yancey.

A large number of mica mines have operated from time to time in all of the above named counties but in recent years most of the production of mica, especially sheet and scrap, has come as a by-product from feldspar mines. In recent years the largest

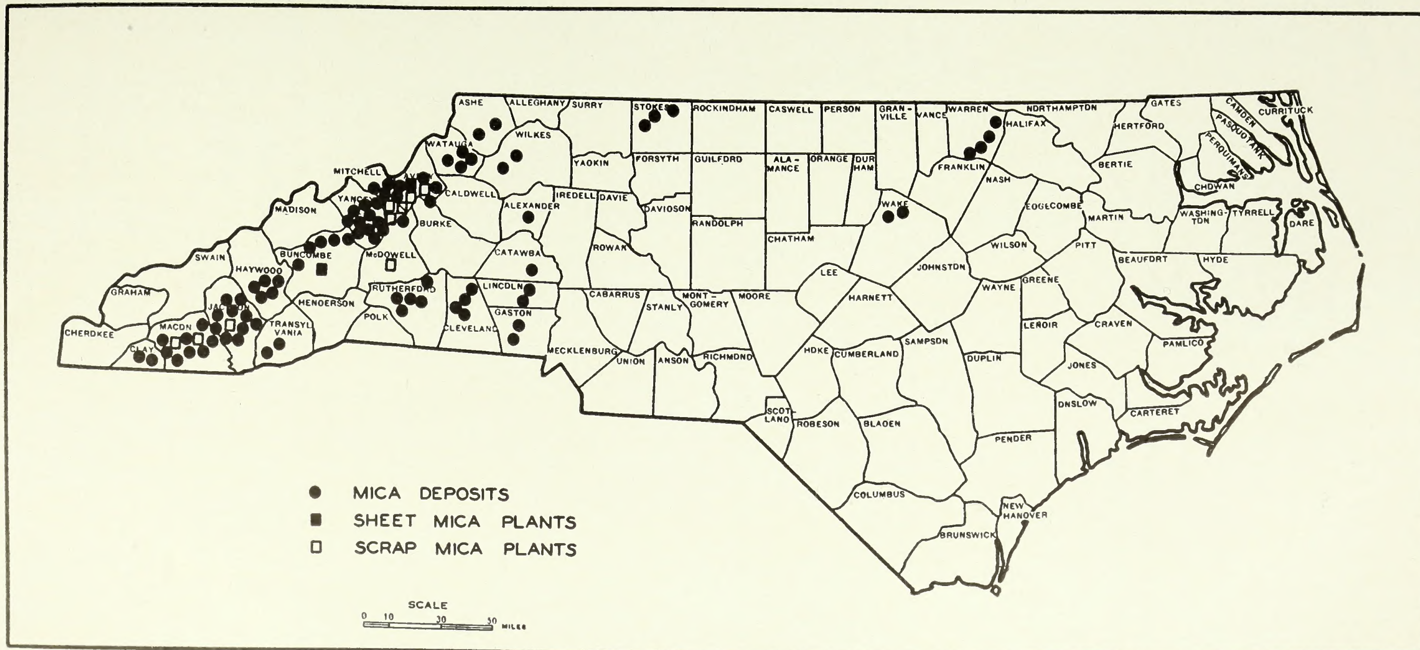


FIG. 17. MAP SHOWING LOCATION OF PRINCIPAL MICA DEPOSITS AND OPERATING SHEET AND SCRAP MICA PLANTS

production of scrap has been as a by-product from the kaolin clay operations. The first mica recovery plant, recovering mica from clay operations, was designed by Harry Gaines, of Canada, at the Norman G. Smith plant at Spruce Pine. As this plant proved successful all of the clay plants have recovered mica as a by-product.

In recent years, on account of the new uses for ground mica, two mica-grinding plants have been constructed and one plant has increased production.

The three outstanding developments in the scrap mica industry during the past few years were the construction of a mica-grinding plant at Franklin by the Franklin Mineral Products Company; the construction of scrap mica recovery plants at all of the kaolin clay plants to recover mica as a by-product; the construction of scrap mica recovery plant by Kaolin, Incorporated, of Spruce Pine, to recover approximately 25 tons per day from kaolin operations; and a new addition to the plant of the Victor Mica Company at Spruce Pine. The addition to the Victor Mica Company plant cost approximately $50,000.

VERMICULITE

The term vermiculite is applied to a group of bronze-colored hydrous micas which exfoliate or expand when heated to a red heat or above. The exfoliation is apparently due to the included water which, when turned to steam, forces apart the flakes or plates of which the mineral is composed. The expansion is always at right angles to the plates or cleavage. In most instances the bronze color brightens when heated.

In 1930 and 1931 when vermiculite became of interest in the State, a great many samples of the various types of vermiculite were collected for tests, which were made by the State Geologist at the State College Laboratories. The samples came from Jackson, Macon, Clay, Transylvania, Yancey, Avery, Mitchell, Madison, Wilkes, Rutherford, Haywood, Wake, and Alexander counties.

Six varieties of vermiculite occur in the State. Some of the deposits may be of commercial value, especially those in Clay, Macon and Jackson counties. The varieties found are jefferisite or culsageeite, the greenish or yellowish-brown material; kerrite,

the pale greenish material; maconite, a dark brown material; lucasite, a yellowish-brown material; willcoxite, a greenish-white material; and dudleyite, a soft bronze or brownish-yellow material. There also occur, in addition to the vermiculites, biotite micas and chlorites which are often mistaken for the vermiculites. These minerals also exfoliate slightly and turn to a bronze color when heated; however, they require a much higher temperature for exfoliation than the true vermiculites.

The vermiculites require temperatures from 300° to 1200° F., while the others require temperatures above 2000° for exfoliation and for giving them the golden-bronze color.

In the tests conducted, the samples submitted were often composed of mixtures of vermiculites and chlorites, mixtures of chlorites and biotites, and mixtures of vermiculites and biotites. The samples which contained mixtures of the various minerals did not exfoliate uniformly, nor did they develop a uniform bronze color. In some instance there was a number of scales or flakes that would exfoliate readily, while other scales or flakes did not change, even though carried to rather high temperatures.

The samples tested showed a variation in exfoliation from three times the normal size to eighteen times the normal. In each case, however, there was some increase in volume with a consequent decrease in weight. This was due to the dispelling of the moisture as well as to the evaporation of the absorbed water. Some of the samples exfoliated suddenly quite similar to decrepitation; that is, with sort of an explosive force. Then, after the explosive force, there was a further gradual exfoliation of the flakes or plates. It was found that some of the material was excellent for heat and sound insulation, while others were not. Some acted as sponges and would not pack, while others would crumble into a dust, with no flakey material and would pack easily. The varieties which would not crumble are suitable for heat and sound insulation, while the material that crumbled easily is suitable for paints, wall paper, and as a lubricant. Some was also tried out in the manufacture of fireproof shingles and proved to be quite satisfactory.

The field work conducted revealed some deposits that might be of commercial value, while a great many proved to be only small pockets of a lenticular nature, with limited horizontal and

vertical dimensions. The most important deposits visited were those on the headwaters of Shooting Creek in Clay County, and those at the old corundum mines in Macon and Jackson counties.

When field work was first begun in North Carolina, it was believed that many high-grade vermiculite deposits existed, but on further exploration and development work, the deposits did not prove to be important from a commercial standpoint. This information bears out the results of investigations in other states.

It is found that any vermiculites that weigh more than six pounds per cubic foot after exfoliation cannot be marketed successfully. Very few of the North Carolina deposits meet these requirements; so few of them yield a blocky, cork-like product, such as the Libby, Montana, material, which the trade demands. Most of the vermiculites decrepitate when expanded, and crumble down easily. However, some of the large automobile manufacturers buy screenings (under 60-mesh) for making plastic insulators for the cars. Also, some of the fine screenings are used in the manufacture of paints and as a substitute for clay in the manufacture of lead for pencils. Below is a size classification based upon the tabulations prepared for the Tennessee Valley Authority:

¼-inch to 20-mesh

House insulation.	Safe and vault linings.	Smelter ladles.
Home refrigerators.	Pipe covering.	Refractory brick.
Auto mufflers.	Boiler lagging.	Insulation cement.

20- to 40-mesh

Auto insulation.	Passenger car insulation.	Annealing steel.
Airplane insulation.	Wall board.	Fire extinguishers.
Refrigerator car insulation.	Water coolers.	Filters.
		Cold storage.

40- to 120-mesh

Linoleum.	Cornice boards.	Dielectric switch boards.
Shingles.		

120- to 200-mesh

Grease lubricant.	Bakelite products.	Tires and rubber goods

200- to 270-mesh

Wallpaper printing. Outdoor advertising paints.	Building up viscosity in oil.	Fireproof cartons for films.

270-mesh

Extender for gold and bronze printing ink or for paint.

For the present, at least, the domestic field—house insulation—is the main outlet but industrial sales opportunities are by no means unimportant. In addition to the foregoing list of uses, special mention should be made of the newly created business for insulating open-hearth steel furnaces. According to a recent review:

Under the trade name "Therm-O-Flake", the Illinois Clay Products Co., Joliet, Ill., produces three different products for furnace installation: Granules, coating, and brick. The granules, which weigh about 5¼ pounds per cubic foot and fuse around 2,500° F., are usually spread on the silica brick of the roof 3 inches deep and covered with a 1-inch layer of "coating". The latter—a fluffy aggregate of vermiculite granlues, mineral fiber, and bond—is used alone for vertical walls; mixed with water, and plastered on a furnace it weighs 15 pounds per cubic foot and melts around 2,300° F. The bricks of this same trade name are quite light, a standard straight, 9 by 4½ to 2½ inches, weighing only 18 ounces; they are a blend of vermiculite granules with refractory fibers and bond and undergo no volume change up to 2,000° F. Over 200 open-hearth furnaces have been supplied with these products, according to the manufacturer. The Johns-Manville Corporation, New York, supplies J. M. vermiculite granules that can be simply raked upon the roof of a furnace in a layer of about 2 inches thick. This company also furnishes a cement, J-M No. 500, comprising granules mixed with asbestos fiber and a binder that coats and seals the pores of the granules.

A wide variety of vermiculite plasters and concrete for both sound and heat insulation is available, using various binders, such as gypsum, bentonite, goulac (paper-making waste liquor), casein, etc. Foundry partings of raw dust and a foundry-sand binder of exfoliated fines are being tried out. Freshly expanded

vermiculite is a powerful desiccant; nevertheless, it has been proposed as a fruit-packing material, and it has found actual employment for packing bottles and other fragile articles. The mineral is mentioned as an insecticide carrier, battery-box filler, thermal jug insulation, roofing filler (tends to raise the melting point of asphalt), sealing compounds (due to its expansive properties), and to prevent "squeaking" shoes. Preliminary tests indicate a large use in oil refining as decolorizing agent, for which purpose it seems to be greatly superior to fuller's earth. One company has launched a Nation-wide advertising campaign claiming that the expansive properties of raw vermiculite can be utilized to prevent power leakage past the rings of worn automobile and other internal-combustion engines, restoring compression.

A number of companies and individuals were mining vermiculite or doing development work in North Carolina in 1935, production being reported by Philip S. Hoyt, Franklin, N. C.

Production figures for vermiculite are not available, but consumption in the United States, almost exclusively from domestic sources except for some experiments with Russian material, doubtless approached 15,000 tons in 1935.

Prices vary; standard-grade raw material, suitable (after being expanded) for house insulation purposes, is sold at $12 to $20 a ton according to locality, the average probably being between $14 and $16 per ton in wholesale quantities. North Carolina raw vermiculite is nominally quoted in trade journals at $7 per ton, f.o.b. mines.

Production

In 1929 North Carolina was the second largest producer of sheet mica in the United States, ranking next to New Hampshire. The output of the mines in North Carolina represented 40 per cent of the total sold by producers in the United States. In 1930 North Carolina outranked all other states in the commercial output of mica. The total value of sheet mica has decreased from $150,293 in 1929 to $77,598 in 1935. However, the scrap and schist output has increased from a total of $53,855 in 1929 to $153,553 in 1935. North Carolina is the largest producer of

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mica schist in the United States, The chlorite grinding plant at Spruce Pine is said be the only chlorite grinding plant in the world. The product from this plant is used especially in the rubber industry.

Below is a table showing the production of mica in North Carolina from 1929 to 1935, inclusive:

PRODUCTION OF MICA IN NORTH CAROLINA
FROM 1929 TO 1935, INCLUSIVE

Year	Sheet Mica		Scrap Mica		Total	
	Pounds	Value	Tons	Value	Tons	Value
1929	894,200	$150,293	3,245	$53,855	3,692	$204,148
1930	749,074	112,451	4,744	75,400	5,119	187,851
1931	389,426	51,657	5,312	79,601	5,507	131,258
1932	127,696	18,322	4,837	56,842	4,901	75,164
1933	162,672	21,107	6,918	74,711	6,999	95,818
1934	293,381	38,674	7,255	101,985	7,401	140,659
1935	512,590	77,598	11,831	153,553	12,087	231,151

Below is the table showing the list of sheet mica plants operating in North Carolina in 1935:

PRODUCERS OF SHEET MICA IN NORTH CAROLINA
IN 1935

Name of Company	Address	Plant Location	County
Asheville Mica Company	Biltmore	Biltmore and Spruce Pine	Buncombe
Southern Mica Company	Spruce Pine	Spruce Pine	Mitchell
Tarheel Mica Company	Plumtree	Plumtree	Avery
Spruce Pine Mica Company	Spruce Pine	Spruce Pine	Mitchell

Below is a list of the mica grinding plants operating in North Carolina in 1935:

MICA GRINDING PLANTS IN NORTH CAROLINA
IN 1935

Name of Company	Address	Location of Plant	Kind of Plant	County
Asheville Mica Co.	Biltmore	Biltmore	Dry ground	Buncombe
Newdale Mica Co.	Newdale	Micaville	Dry ground	Yancey
Southern Mica Co.	Spruce Pine	(Erwin, Tenn., (Franklin, N. C.	Dry ground	(Macon (Yancey
Franklin Mineral Products Co.	Franklin	Franklin	Wet and Dry ground	Macon
Marion Mica Mills	Marion	Marion	Wet ground	McDowell
D. T. Vance	Plumtree	Plumtree	Wet ground	Avery
Vance-Barrett, Inc.	Plumtree	Plumtree	Wet ground	Avery
Philip S. Hoyt	Franklin	Franklin	Dry ground	Macon

Below is a list of the producers of mica in North Carolina in 1935:

PRODUCERS OF MICA IN NORTH CAROLINA IN 1935

Name of Producer	Address	Name of Mine	Location	County
J. C. Burleson Mica Co.	Spruce Pine	Big Ridge	Hazelwood	Haywood
Carolina Mineral Co.	Spruce Pine	English Knob, Hoot Owl	Spruce Pine	Mitchell
Elmore Brothers	Casar	Burr Knobb	Casar	Cleveland
Franklin Mineral Products Company	Franklin	....	West Mills	Macon
J. C. Pittman	Penland	Chestnut Flat	Penland	Mitchell
Rickman, Wright, Ruess and Sisk	Franklin	Boyd Knob	Franklin	Macon
Spruce Pine Mica Company	Spruce Pine	Nos. 10, 21, 22	....	Mitchell
Tennessee Mineral Products Company	Spruce Pine	Deer Park, Smith	Penland	Mitchell
W. W. Wiseman	Spruce Pine	Bucklin	....	Mitchell
D. T. Vance	Plumtree	....	Plumtree	Avery
Fureka Mica Mfg. Co.	Waynesville	Grassy Ridge	Balsam	Jackson
Meadow Mining Company	Plumtree	Meadow	Plumtree	Avery
General Mica Company	Penland	Bailey	Penland	Yancey
Harris Clay Company	Dillsboro	Lunday, Spark, Penland	Lunday, Spruce Pine, Franklin	Mitchell, Macon

QUARTZ

Quartz is one of the most abundant of all minerals, and is the chief constituent of a great many rocks, especially acid igneous rocks as granites, etc.; metamorphic rocks, as quartzites and acid schists; and sedimentary rocks, as sandstones. It varies widely in its mode of occurrence and uses.

The form of quartz used commercially in this State is the massive crystalline variety, often known as vein quartz; "flint," a by-product of the feldspar and kaolin clay mines; quartzite, which when ground, is used as sand and in the ceramic trade. There are also some varieties, such as rose or smoky quartz, amethyst, etc., used as gems.

Quartz occurs at a great number of places in this State. The production comes chiefly from the feldspar mines of Mitchell, Avery, and Yancey counties. The quartzite rock of Cherokee County has been quarried at a few localities for use as a flux in copper smelting. This vitreous variety of quartzite occurs in the Cambrian formations and extends over several of the western counties but has been mined only in Cherokee. In this county it

is known as the "Tusquitee quartzite" and parallels the Murphy marble. Important deposits of quartz have recently been found in Buncombe and Transylvania counties.

The vein quartz also occurs in several of the lower Piedmont counties as Anson, Montgomery, Moore and Harnett. At times, it is found in its original position cutting the old "slates" while at others it occurs as pebbles in the Lafayette formation of the Coastal Plain deposits.

The chief uses of quartz are: in pottery manufacture to diminish the shrinkage of the ware in burning; in the manufacture of scouring soaps; paints; wood filler; sandpaper; filters; and tooth powders; as a flux in copper smelting; in the manufacture of silicon and ferrosilicon. A great deal of the chemical ware is made of fused quartz. The massive quartz and quartzite are employed as filters for acid towers. The crystalline variety is also used in the manufacture of lenses.

The production of quartz in 1933 was greater than that of the previous year. That produced in this State was used chiefly in the ceramic trade and came as a by-product from the feldspar mines. It was sold in the crushed, ground and crude forms. The average price of the crushed was about $6.50 per ton; the ground from $25.00 to $30.00 per ton; and the crude from $2.50 to $7.50 per ton.

Along with the recent important developments in the kaolin industry in the Spruce Pine area, the development in the quartz industry has increased considerably. In 1933 when the world's largest telescope was in the making for the California Institute of Technology, engineers were sent out by the Corning Glass Company in search of a very high type quartz to be used in the making of the 200-inch lens. The quartz for the lens was taken from the Chestnut Flat mines near Spruce Pine. The quartz is considered some of the finest found in America. It is pure white with no iron or feldspar. All of the quartz used in the lens was shipped from the Spruce Pine district, and thus the product was brought before the public. After the Corning Glass Company secured quartz for the telescopic lens, another order by the same company was given for 500 tons of quartz. This material is to be used in the manufacture of glass bricks for the construction of an office building for the company in New York City. During the past few years the sale of quartz has been rather limited,

Fig. 18. N. N. Rogers, Shooting Creek, Mineral Prospector at His "Laboratory"

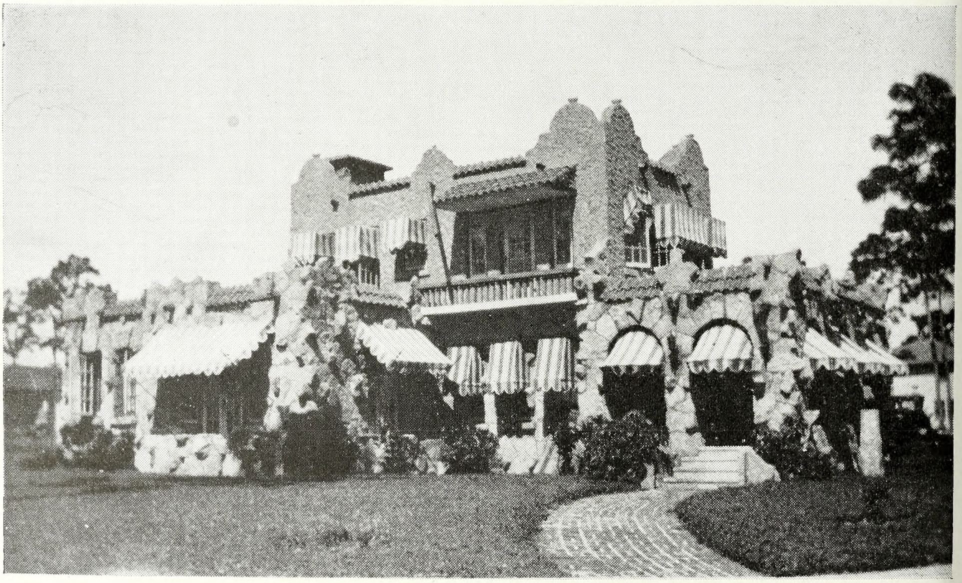


Fig. 19. Florida Home Constructed of North Carolina Quartzite

even though it is found in large quantities; however, with the development in the manufacture of glass bricks, this industry should become an important one for western North Carolina.

The price of quartz is relatively small as compared with feldspar, mica, and kaolin, the three principal minerals with which it is associated. With the new developments, the price should increase. The quartz so far produced has been produced principally as a by-product from the feldspar and mica mines. In view of the fact that it is produced as a by-product, the cost of production is rather low, therefore the miner can afford to sell it at a very low price.

The principal uses for the high-grade quartz in the past has been mostly in the manufacture of telescopic lenses, condensing lenses in motion picture machines, and for glass for windows in sanitoriums. Since the material made from the high-grade quartz withstands sudden changes in temperature, it is especially suitable for condensing lenses in motion picture machines where the heat of the high-intensity arc light often breaks glass. Also, it is suitable for retorts and other laboratory apparatus which may be plunged into ice water without breaking. Since windows manufactured from this quartz admit one-third or more of the violet rays of the sun than ordinary glass, it is an important material for the manufacture of glass to be used in the windows of sanitoriums and hospitals.

With the recent developments in the manufacture of brick from quartz, there is promise of great expansion in the quartz industry. Producers of the mineral in North Carolina are watching with interest developments which are taking place.

Glass houses were thought to be impracticable, but recent developments show that it may be possible for people to live in glass houses. Many people saw glass houses for the first time at the World's Fair in Chicago, and yet they are few in number and considered a novelty. The future may see the development of such houses on a large scale. The five-story office building being erected by the Corning Glass Company in New York City proves that glass brick can be used in the construction of large buildings.

The Pilot Life Insurance Company office building near Greensboro has special quartz-built windows, permitting the

entrance of the healthful rays of the sun. The windows are kept closed tightly at all seasons, as fresh air is brought in by an air-conditioning system.

Since quartz is one of the most common minerals of the earth's crust, it is reasonable to believe that, in the future, houses may be built without windows, as the walls will be constructed of quartz brick.

The production of quartz in North Carolina during the past few years has been rather low, except for the year 1933 when the quartz for the telescopic lens was shipped from the State. That year the production was $65,483 as compared to $6,086 the following year. The average price per ton of crushed quartz was $11.15 in 1929 but decreased to $4.53 in 1932. The average increased to $11.21 for 1935.

PRODUCTION OF QUARTZ IN NORTH CAROLINA
FROM 1929 TO 1935, INCLUSIVE

Year	Tons	Value	Average Value Per Ton
1929	$ 2,493	$28,709	$11.15
1930	2,981	23,838	8.00
1931	1,807	11,460	6.34
1932	1,535	7,045	4.53
1933	10,782	65,483	6.07
1934	493	8,036	16.30
1935	675	7,571	11.21

PRODUCERS OF QUARTZ IN NORTH CAROLINA
IN 1935

Name of Company or Owner	Address	Mine Location	
		Town	County
Charlotte Chemical Labortories, Inc.	Charlotte	Mt. Holly	Gaston
J. C. Pittman	Penland	Penland	Mitchell
Carolina Minerals Company, Inc.	Spruce Pine	Spruce Pine	Mitchell
F. B. Fortner	Spruce Pine	Green Mountain	Mitchell
Galen Sparks	Spruce Pine	Green Mountain	Mitchell
Tennessee Mineral Products Corp.	Spruce Pine	Penland	Mitchell
Whitehall Company, Inc.	New York City	Penland	Mitchell
Carolina China Clay Company	Penland	Penland	Mitchell

SAND AND GRAVEL

The sand and gravel produced in North Carolina consists chiefly of building sand, paving sand, engine sand, gravel for railroad ballast, gravel for road making and a small amount of fine sand for polishing and grinding. Up to the present time no glass sand has been produced although a great many deposits were examined and tests made on samples from Moore County in the vicinity of Aberdeen.

The chief types of sand and gravel produced in this State are for the construction of buildings and roads. These materials are used for making plaster, mortar, concrete, and concrete products, as brick culvertpipe, blocks, etc. Sand and gravel suitable for all of the above products are found in the State. Before being used as such, all of the sand and gravel must be washed and screened.

Sand, for all types of products, is composed chiefly of the mineral quartz, SiO^2, and when pure it is colorless or white with a glassy appearance. In the scale of hardness it is about 7, hard enough to scratch steel. The quality of a sand depends on the shape and size of the grains and on the amount of impurities. The chief impurities in a sand depend entirely on the type of rocks from which it comes. Since the rocks of this State are chiefly the crystalline variety, composed of quartz, feldspar, muscovite mica and the ferromagnesian minerals, as biotite mica, hornblende, augite, etc., the chief impurities would be feldspar, mica, hornblende and clay which is the result of the weathering of these minerals, as well as organic material. Most of the clay, mica, and organic matter is eliminated when the material is sent through the washing and screening process.

The gravels of the lower Piedmont and Coastal Plain deposits are composed of the more or less rounded quartz pebbles which originated in the quartz veins that cut the Proterozoic rocks which lie to the west of the fall line. The round form is due to the wearing caused by stream and wave action before and during deposition.

The gravels of the upper Piedmont and Mountain sections of the State are composed of quartz pebbles and fragments of the older crystalline rocks. These gravels are also more or less

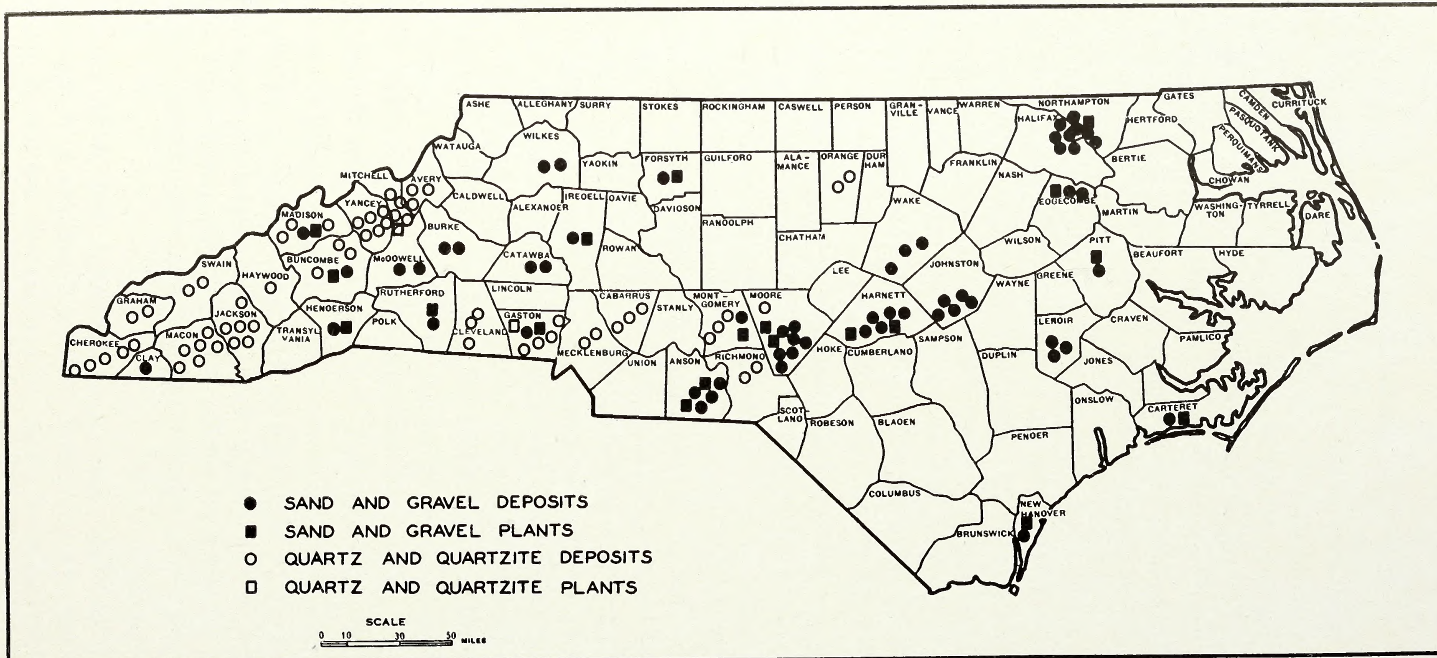


Fig. 20. Map Showing Location of Sand and Gravel, Quartz, and Quartzite Deposits and Recovery Plants

rounded and vary in size from coarse sand to large-sized boulders. Crushing as well as screening has to be applied to a great deal of these gravels before being suitable for the trade.

The production of sand and gravel continues to rank as one of the more important mineral industries in North Carolina. However, on account of the decrease in building construction, the production of sand and gravel decreased in total value from $1,020,533 in 1929 to $99,640 in 1932. This latter figure is one of the lowest in the history of the industry. However, with an increase in the building industry, the production in 1935 increased to $310,291.

PRODUCTION OF SAND AND GRAVEL IN NORTH CAROLINA FROM 1929 TO 1935, INCLUSIVE

Year	Quantity (short tons)	Value
1929	1,004,858	$1,020,533
1930	800,222	437,555
1931	414,282	238,053
1932	177,074	99,640
1933	524,903	201,113
1934	338,381	225,588
1935	815,580	310,291

PRODUCERS OF SAND AND GRAVEL IN NORTH CAROLINA IN 1935

Name of Company or Producer	Address	Plant Location	
		Town	County
W. R. Bonsal Company	Hamlet	Lilesville	Anson
Sand and Gravel Company	Tarboro	Tarboro	Edgecombe
Charlotte Chemical Laboratories, Inc.	Charlotte	Mt. Holly	Gaston
J. L. McKinney Sand Company	Mt. Holly	Mt. Holly	Gaston
Lillington Stone Company	Lillington	Lillington	Harnett
Marshall Sand Company	Marshall	Marshall	Madison
T. L. Sellers	Paw Creek	Paw Creek	Mecklenburg
Patt C. Harman	Candor	Candor	Montgomery
Aberdeen Sand Company, Inc.	Norfolk, Va.	Aberdeen	Moore
S. W. Wilson & Son	West End	West End	Moore
Theodore G. Empie	Wilmington	Wilmington	New Hanover
Lawrence Stone & Gravel Co.	Raleigh	Garysburg	Northampton
Greenville Sand & Transfer Co.	Greenville	Greenville	Pitt
Jobe Sand Company	Forest City	Forest City	Rutherford

STONE

The stone industry from 1929 to 1935 followed more or less the trend of the construction industry during those years.

PRODUCTION OF BUILDING STONE IN NORTH CAROLINA FROM 1929 TO 1935, INCLUSIVE

Year	Granite, etc.	Limestone and Marble	Total
1929	$5,344,032	$277,846	$5,621,878
1930	3,473,406	244,038	3,717,444
1931	3,607,966	98,956	3,706,922
1932	1,323,780	128,172	1,451,952
1933	1,631,464	305,029	1,936,493
1934	1,706,570	134,026	1,840,596
1935	1,422,174	120,418	1,542,592

GRANITE

There is probably no other State in the Union that has a greater distribution of granite and allied stone, as syenite, diorite, rhyolite than North Carolina. Neither is there any state that has a greater variety of colors among the granites. The granites found in the State are among the strongest, most massive and most durable in America. They are adapted to a wider range of structural and ornamental uses than any other stones.

The granites of North Carolina are distributed over more than half the area of the State but the productive parts are limited to an area of considerably less extent. Many of the granite areas have produced stone in quantity during many years but the present producing areas are confined to the districts shown on the accompanying outline map.

Geographically, the distribution of the granites and allied stones is divided into three physiographic divisions or provinces of the State; namely, the Coastal Plain, the Piedmont Plateau and the Mountain Region. The larger part of the granites, however, are confined chiefly to the limits of the Piedmont Plateau region. There are smaller workable areas of excellent grades distributed over several of the mountain counties as well as one or two of the Coastal Plain counties. There are numerous areas of gneissic granites which have shown a production in the past.

In 1875, W. C. Kerr, in his report, "Geology of North Caroline," outlines the granite producing areas in the State as follows:

I. The Coastal Plain Region
II. The Piedmont Plateau Region
  1. The Northeastern Carolina Granite Belt
  2. The Carolina Metamophic Slate and Volcanic Belt
III. The Carolina Igneous Belt (The Main Granite Belt)

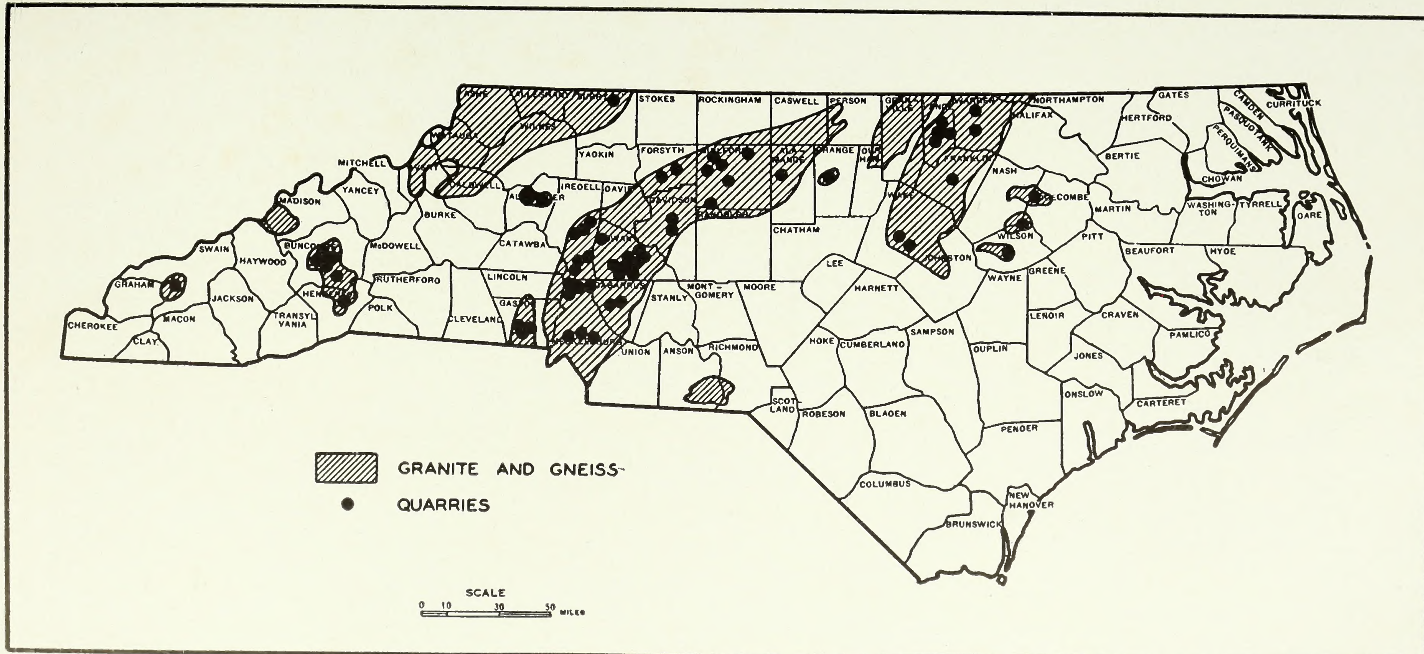


FIG. 21. MAP SHOWING LOCATION OF MAIN GRANITE BELTS AND QUARRIES

The Coastal Plain in North Carolina extends inland for a distance of 120 to 140 miles and has an approximate area of 22,000 square miles, or a little less than one-half the rea of the State. Near the western border of this region along the Atlantic Coast Line Railroad several quarries have been worked, three of which are still producing. The Principal granite producing areas are in Wilson and Nash counties. The granite exposures in these counties are due to the removal of the overlying sandy sediments and are rather small in extent.

The granites of these areas are massive biotite rocks varying from fine even granular to rather coarse porphyritic in texture. The color is chiefly gray but varies at times to a decided pink. Considerable jointing occurs usually in the chief directions, northwest, northeast and north-south. These granites are considerably younger than the schists and gneisses which enclose them as evidenced by the nature of the contacts. The granites have a decided massive structure as contrasted to the schistose structure of the surrounding rocks.

The composition of the granites of the Coastal Plain region is chiefly feldspar and quartz with varying amounts of biotite and hornblende. The abundance of biotite and hornblende gives a decided gray appearance to the stone. The pink-colored granite has more feldspar and less quartz than the gray.

The Piedmont Plateau region in North Carolina, lying between the Coastal Plain and the Mountain section, has an average width of 125 miles and covers approximately 21,000 square miles. In this region are found the most important granite areas of the State. Thirty of the thirty-eight so-called Piedmont counties have known granite deposits, ten of which showed a production in 1935.

The Northeastern Carolina Granite Belt includes a whole or a part of Franklin, Granville, Wake, Warren, and Vance counties. It is bound on the east by the Coastal Plain deposits and on the west by the Triassic sandstone area and the so-called metamorphic slate-schist volcanic belt. The northern end of the belt extends well up into the State of Virginia.

All of the granites of this belt are more or less schistose in structure and are often cut by younger more or less basic rocks. Usually the schistosity is not so completely developed as to render the rock unsuitable for most of the uses to which the

FIG. 22. GRANITE QUARRY NEAR SALISBURY, ROWAN COUNTY

FIG. 23. BRICK SHALE QUARRY, STANLY COUNTY

massive granites are applied. At many places, especially in the vicinity of Raleigh, Wake County, the granites are decidedly gneissose which causes them to have the tendency to split along definite lines. This type of stone, however, is especially desirable for residences on account of this quality. It also has a variety of colors which grade from the browns through the yellows to the light grays. These colors are due to the oxidation of the ferruginous minerals as biotite and hornblende. When buildings are constructed of this stone they have a variegated as well as a very attractive appearance due to the colors.

The principal quarries in the belt are located in the vicinity of Raleigh in Wake County, and Greystone and Middleburg in Vance County. The State Capitol building was built of stone from these quarries and it is said to be one of the most attractive Capitol buildings in the United States.

The area including the metamorphic slate and volcanic rocks extends in a northeast-southwest direction in the lower Piedmont section entirely across the State and is 8 to 50 miles in width. It is bound on the west by the Main Granite Belt and on the east by the Triassic sandstone area. In this belt there occur numerous outcrops of granite, especially in the northeastern section in Durham and Granville counties. In the vicinity of Chapel Hill, in Orange County, a great many outcrops of granite occur. Several small quarries have been opened to supply the local demands.

In this slate or volcanic belt occur highly metamorphosed volcanic rocks, such as rhyolite, dacite, andesite, and trachyte, which have been used for building purposes. Just west of Hillsboro, in Orange County, is located the quarry which supplied the stone for the Greater Duke University building program. In this one large quarry are found several types of igneous rock which belong to the granite group, among which are especially rhyolite and andesite with possibly some dacite and volcanic tuff and breccia. The whole group has been so metamorphosed that it is impossible to locate the contact between the various types. The color is principally a gray or grayish-green with varying amounts of yellow, yellowish-green, and dark green. The gray color is due to the abundance of light-colored feldspars, the green to the abundance of epidote which evidently replaced much of the feldspar during the period of metamorphism, while

the yellows and yellowish-greens are due to the oxidation or partial oxidation of the iron silicates. Many joint planes occur in this stone which give smooth faces to the blocks.

The Carolina Igneous Belt occupies a nearly central position in the Piedmont Plateau region and extends in a northeast-southwest direction from the South Carolina line on the south nearly to the Virginia line on the north. The width varies from 15 to 50 miles and is traversed for most of its length by the main line of the Southern Railway. The belt is further crossed by several other railroads, thereby making it one of the most accessible granite areas in the State. On account of its accessibility to transportation it is one of the largest granite producing areas in the South. Granite from this section is shipped to many parts of the United States.

This area is composed principally of plutonic rocks belonging to two chief types—granite and diorite. The exposures in road and railroad cuts show both the massive and gneissic structures, with possibly the gneissic predominating. Other than the huge granite and diorite masses, there are numerous dikes which penetrate the older rocks. These dikes are principally diabase with other basic igneous rocks.

Taking the area as a whole there are two phases of the granite which are prominently developed, the porphyritic and the even granular, which grade from one into the other. A very pronounced zone of the coarse-grained or porphyritic granite can be traced through a number of counties along the western margin of the belt. The phenocrysts of feldspar marked by idiomorphic outlines, in the extreme cases reach 2 inches in length by 1 inch across.

The even granular granites outcrop more along the eastern margin of the belt but especially in the vicinity of Salisbury in Rowan County. These granites are hardly without exception biotite-bearing and the color usually some shade of gray. They vary in texture from fine to coarse but the medium grain is the most common. Locally, the granites vary so it might be well to describe a few of the outstanding types.

Probably the outstanding type of stone found in this belt is known as "Leopardite," so named on account of the spotted appearance. This stone, a quartz-porphyry, was first mentioned in the "American Journal of Science," in 1853, by C. L. Hunter,

in a paper which gave a brief description of it. A fresh specimen of the rock is nearly white, tinged with the faintest greenish tone in places, and penetrated by long more or less parallel streaks or pencils of a black color. These pencils are composed of the oxides of iron and manganese. The stone, when cut at right angles to the pencils, presents a very spotted appearance, hence the name, but if cut parallel to them, it presents a surface streaked with long, somewhat irregular, though roughly parallel, black lines, assuming at times dendritic or fern-like forms.

This stone is composed essentially of feldspar with quartz next in abundance. The black pencil-like masses are composed of the oxide of iron and manganese the origin of which is undetermined. In spite of these stains or streaks of dark-colored material, the rock is extremely hard and takes an excellent polish. It could be used to splendid effect in inlaid work.

Ten miles west of Lexington, in Davidson County, there is another type of rock, known as "Orbicular Gabbor Diorite," which is exposed at several places. This rock has a very peculiar appearance due to the large masses of a dark green bi-silicate. The matrix and dark nodules are essentially the same minerals but are arranged in different proportions. The matrix is composed largely of feldspar with a subordinate amount of dark-colored minerals while the nodules are essentially the ferromagnesian or dark-colored minerals with a subordinate amount of feldspar. The rock takes a very good polish and can be used for a great many purposes.

The most important producing section in this belt is in the vicinity of Salisbury, Rowan County. The granites of this area are from gray to pink in color and both may occur in the same quarry. They are composed essentially of feldspar and quartz with minor amounts of biotite and hornblende. They take a good polish and can be used for any purpose to which granites are applied. This county produced over one million dollars worth of granite in 1928.

The rocks of the western Piedmont gneiss and granite belt are composed largely of schists and gneisses of the mica type. They vary considerably in the various sections of the area and many of them are probably of sedimentary origin. There are, however, large masses of true igneous rocks which have been

little altered. The more important areas of workable deposits are found in Surry, Wilkes, Alleghany, and Alexander counties. There are, however, other scattered areas but so far have not proved to be of commercial importance due to absence of transportation facilities.

The most important commercial granite deposit in this belt, or even in the South, occurs in the northeastern section of Surry County. It is owned and operated by the North Carolina Granite Corporation, the largest producer of granite in the State. These quarries were first opened in 1889 and the first shipment was made in July, 1890. The production has increased yearly until today the annual production is a little over $1,000,000. The stone produced by this company is known throughout the eastern United States for its uniform color and composition. It is sold under the trade name "Mt. Airy Granite." The quarry operated by this company is the largest open-faced granite quarry in the world.

The stone produced by the North Carolina Granite Corporation is noted for its beautiful white color. It is composed essentially of quartz and feldspar with a very small amount of mica, zircon, epidote, and very little iron oxide. The minerals are so arranged that a very uniform color is to be had throughout the entire deposit. There is no segregating of the white or dark materials.

The average crushing strength is a little over 20,000 pounds per square inch. The lowest test obtained was 18,384, while the highest was 22,469 pounds per square inch. The late Dr. F. P. Venable, Professor of Chemistry, University of North Carolina, made several tests on its capacity for absorbing water and found that "no sample shows note porosity nor absorbing power for water." The above tests are ample to show the marked resistance of the granite to the normal atmospheric forces, and durability when placed under such conditions. It is a very high-grade granite and can be used for any purpose to which stone is applied.

The Appalachian Mountain granite area includes several of the mountain counties which lie between the Piedmont area and the Tennessee line. However, only three, Buncombe, Henderson and McDowell, have shown a production the past few years. The counties of the northwestern section of this belt do not have sufficient transportation facilities to compete with the other large producing areas.

The granites, both massive and schistose in structure, are rather widely distributed over the Mountain region, with the schistose by far the more important. All of the granites are biotite-bearing. The color, then, is some shade of gray, depending on the amount of biotite in the rock. The gneisses are probably of both igneous and sedimentary origin. The true granites occur at a great number of places in the form of dikes and other intrusive masses.

In Madison County, near Hot Springs, there is an extensive deposit of biotite-epidote granite with a pleasing dark green and mixed yellow color. So far, this stone has never been quarried but the economic possibilities are great. The so-called unakite is found associated with this rock. The unakite is a beautiful variety of granite composed of yellow-green epidote, dull pink or red feldspar, and quartz. So far, this rock has proved only of scientific interest, as no attempt has been made to work it commercially as the principal areas are almost inaccessible and could only be developed at considerble cost.

The stone produced in the western mountain district up to the present has been used chiefly as a concrete aggregate. Some of the more pleasing colors of the banded gneiss has been used to some extent in residences in and around Asheville and Hendersonville, N. C.

PRODUCTION OF GRANITE AND ALLIED STONE IN NORTH CAROLINA FROM 1929 TO 1935, INCLUSIVE

Year	Tons	Value
1929	2,848,080	$5,336,032
1930	1,957,880	3,469,156
1931	2,171,510	3,605,166
1932	744,550	1,260,380
1933	987,030	1,629,064
1934	1,157,810	1,648,251
1935	1,097,480	1,407,743

PRODUCERS OF GRANITE IN NORTH CAROLINA IN 1925

Name of Producer	Address	Location of Quarry	
		Town	County
B. V. Hedrick Gravel & Sand Co.	Lilesville	Lilesville	Anson
County of Buncombe	Asheville	Asheville	Buncombe
Grave Stone & Sand Company	Swannanoa	Swannanoa	Buncombe
Asheville Quarry Company	Asheville	Asheville	Buncombe
Lloyd A. Whitener	Granite Falls	Granite Falls	Caldwell
City of Lenoir	Lenoir	Lenoir	Caldwell
Virginia-Carolina Granite Co.	Shelton	Shelton	Caswell
City of Shelby	Shelby	Shelby	Cleveland
T. L. Pendegrass	Durham	Durham	Durham
City of Durham	Durham	Durham	Durham
Piedmont Quarries Co.	Winston-Salem	Winston-Salem	Forsyth
Gaston Granite Co., Inc.	Gastonia	Gastonia	Gaston
F. T. Yow	Greensboro	Greensboro	Guilford
Lillington Stone Co.	Lillington	Lillington	Harnett
The Interstate Amiesite Co., Inc.	Wilmington, Del.	Hendersonville	Henderson
Wright & Dixon	Hendersonville	Hendersonville	Henderson
J. W. Newman	Hendersonville	Hendersonville	Henderson
Sugaw Creek Stone Co.	Charlotte	Charlotte	Mecklenburg
Carolina Crushed Stone Co.	Charlotte	Charlotte	Mecklenburg
Dunavant Quarries, Inc.	Charlotte	Charlotte	Mecklenburg
Duke Construction Co.	Durham	Hillsboro	Orange
J. B. Ross	Chapel Hill	Chapel Hill	Orange
H. P. Stirewalt	Salisbury	Salisbury	Rowan
Fricke Brothers	Salisbury	Faith	Rowan
Rowan County Highway Dept.	Salisbury	Salisbury	Rowan
B. V. Hedrick	Salisbury	Granite Quarry	Rowan
M. L. Hess	Salisbury	Faith	Rowan
W. F. Brinkley	Granite Quarry	Granite Quarry	Rowan
Georgia Granite Corporation	Elberton, Ga.	Granite Quarry	Rowan
Carolina Pink Granite Co.	Salisbury	Granite Quarry	Rowan
Gardner Brothers	Salisbury	Salisbury	Rowan
Ludwig and Hess	Salisbury	Salisbury	Rowan
Collins Durax Co.	Salisbury	Salisbury	Rowan
Harris Granite Quarries Co.	Salisbury	Granite Quarry	Rowan
Mt. Airy Granite Cutting Co.	Mt. Airy	Mt. Airy	Surry
N. C. Granite Corporation	Mt. Airy	Mt. Airy	Surry
E. C. Bivens	Mt. Airy	Mt. Airy	Surry
Southern Aggregates Corporation	Raleigh	Wake Forest Wendell	Wake
State Highway Commission	Raleigh	Raleigh	Wake

GRANITE FINISHING PLANTS IN NORTH CAROLINA IN 1935

Name of Owner	Address	Location of Plant	
		Town	County
Lloyd A. Whitener	Hickory	Hickory	Caldwell
City of Lenoir	Lenoir	Lenoir	Caldwell
Piedmont Quarries Company	Winston-Salem	Winston-Salem	Forsyth
Raleigh Granite Company	Raleigh	Stokesdale	Guilford
Greensboro Cut Stone Company	Greensboro	Greensboro	Guilford
Harris Granite Company	Salisbury	Granite Quarry	Rowan
Mt. Airy Granite Cutting Company	Mt. Airy	Mt. Airy	Surry
N. C. Granite Corporation	Mt. Airy	Mt. Airy	Surry
Sargeant Stone Cutting Plant	Mt. Airy	Mt. Airy	Surry
The Nantahala Company	Nantahala	Hewitts	Swain
Southern Aggregates Corporation	Raleigh	Rolesville	Wake

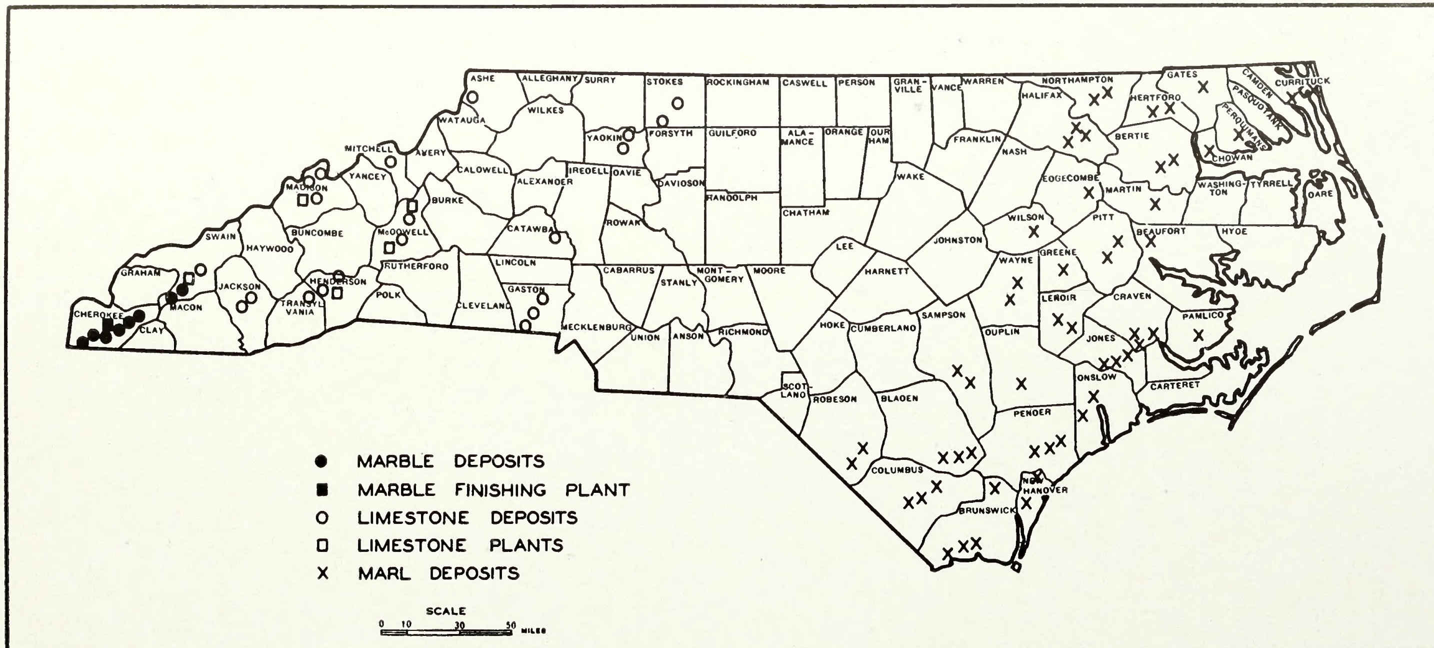


Fig. 24. Map Showing Location of Marble, Limestone and Marl Deposits

MARBLE AND OTHER FORMS OF LIMESTONE

The marble and limestone deposits of North Carolina occur chiefly in Macon, McDowell, Swain, Cherokee, Buncombe, Henderson, and Madison counties, in the extreme southwest corner of the State. However, small lenticular deposits of low-grade limestone are found outcroping in Catawba, Clay, Cleveland, Gaston, Jackson, Lincoln, Macon, Mitchell, and Stokes.

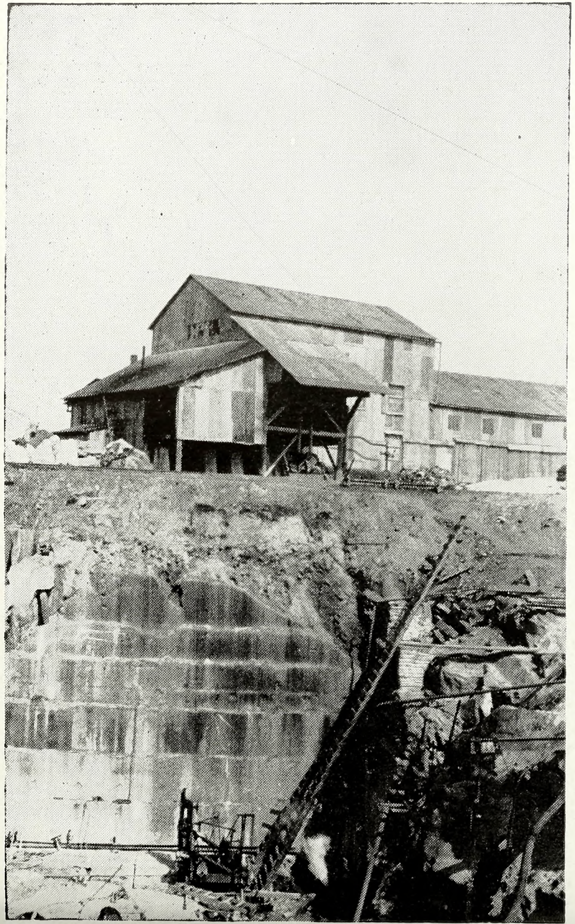
The principal uses of the marbles and limestones in North Carolina are in the building and construction industries, as road metal and in the manufacture of lime. So far, no deposits have been found which are suitable for the manufacture of Portland cement. Generally speaking, the marbles and limestones contain too much magnesia and silica.

The most important development in the marble industry in the last few years was the construction of a marble finishing plant by the Columbia Marble Works, Tate, Georgia, near the village of Marble in Cherokee County. This plant was constructed after large areas had been core-drilled, on which large deposits of high-grade marble were found. It is estimated that the plant cost $150,000.

The company produces a high-grade material, some of which is finished at the plant in Cherokee County but most of it is shipped to finishing plants in Tennessee.

The most important development in the limestone industry was by the State Highway and Public Works Commission in McDowell County. The State purchased a tract on which large high-grade deposits of limestone are found. The State plans to install crushers and screens to produce one thousand tons of crushed stone per day for road construction and maintenance work. Since the State uses approximately 400,000 tons annually in State maintenance work, this quarry will supply most of the stone.

As a by-product from this stone quarry, pulverized limestone will be produced for agricultural purposes. Since the farmers in North Carolina use approximately 100,000 tons annually of agricultural lime, the production of agricultural lime at this plant will mean a saving of three to five hundred thousand dollars annually in freight rates in addition to approximately the same amount in the purchase of limestone. The commission proposes to sell the pulverized limestone at actual cost, which, it is believed will



QUARRY AND PLANT

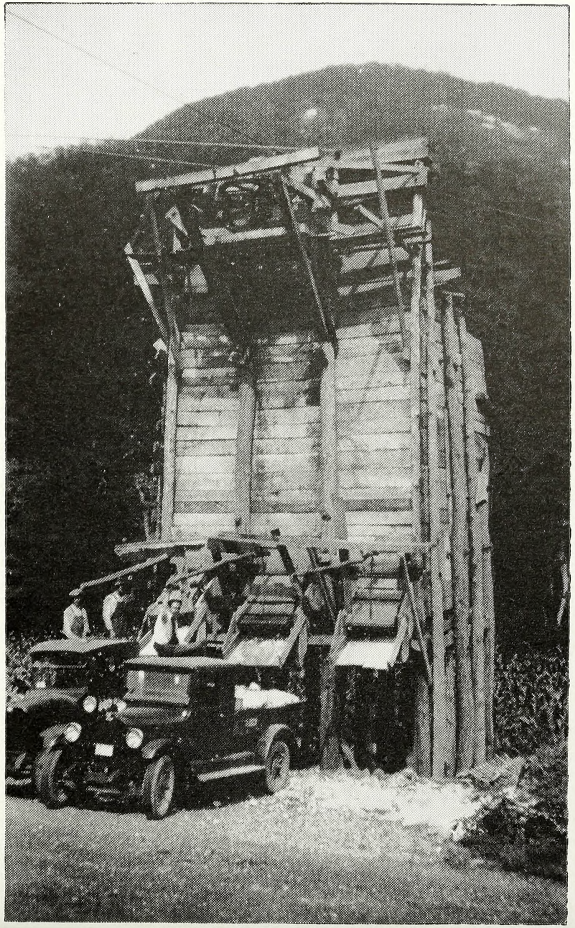


FIG. 26.

not exceed $1.00 per ton, f.o.b. quarry. In addition to the cost per ton, the farmers will pay the freight to the distributing centers, which should not exceed an average of $1.50 per ton. This means that the farmers in North Carolina can have limestone delivered to the various towns at a cost not to exceed $3.00 per ton in comparison with the present price of $5.00 to $8.00 per ton.

The State Geologist prepared a report for the Highway Commission on this property, and later Mr. Frank L. Hess, of the U. S. Bureau of Mines, prepared a report which showed a tonnage of approximately 30,000,000. This tonnage is sufficient to meet the needs of the State for many years. The chemical analyses by industrial and Government chemists show a very high-grade limestone averaging 95 per cent or better.

PRODUCTION OF MARBLE AND OTHER FORMS OF LIMESTONE FROM 1929 to 1935, INCLUSIVE

Year	Value
1929	$277,846
1930	244,038
1931	98,956
1932	128,172
1933	305,029
1934	134,026
1935	120,418

PRODUCERS OF MARBLE AND OTHER FORMS OF LIMESTONE IN 1935

Name of Producer	Address	Location of Quarry	
		Town	County
Columbia Marble Quarry Company	Atlanta, Ga.	Marble, Murphy	Cherokee
J. M. Kilpatrick	Marble	Marble	Cherokee
Meadows Fertilizer Company	James City	James City	Craven
Fletcher Limestone Company	Fletcher	Fletcher	Henderson
Blue Ridge Lime & Stone Corp.	Asheville	Fletcher	Henderson
B and C Lime & Stone Company	Fletcher	Fletcher	Henderson
Government Crushing Plant	Hot Springs	Hot Springs	Madison
Commissioners New Hanover County	Wilmington	Castle Hayne	New Hanover
The Nantahala Company	Nantahala	Hewitt	Swain

TALC, PYROPHYLLITE, AND SOAPSTONE

There are two varieties of talc which are found in North Carolina: the true talc or steatite, the hydrous magnesium silicate, and pyrophyllite, the hydrous aluminum silicate. These

two minerals are used interchangeably in most materials, but there are a few products which require certain specifications that are not met by both minerals.

The true talc or steatite variety is found principally in the mountain section in Cherokee, Swain, Avery, Yancey, Mitchell, and Madison counties. The most important deposits from a commercial standpoint occur in Cherokee and Swain counties. These deposits parallel the Murphy branch of the Southern Railroad, and occur in lens-shaped masses varying from a few feet to 1,500 feet in length and in width up to 100 feet or more. In the past, eighteen mines and prospects have been worked. The principal centers of production are in the vicinity of Hewitt, Maltby, and Kinsey. However, a small grinding plant was located at Marshall in Madison County, and showed a small production for a few years.

The deposits in the Cherokee-Swain County Belt occur associated with the limestones and marbles, while the deposits in the other counties occur as alteration products from the peridotites and associated rocks.

The talc of Cherokee County ranks with the best produced in the world, and is used especially in the bleaching industry and in the manufacture of toilet articles.

The talc from the other counties is much lower grade and has been used as tombstones, in fire places and as hearthstones. The talc has such impurities as magnetite, chromite, vermiculite, and asbestos.

The pyrophyllite deposits are confined to the lower Piedmont counties, especially Moore, Randolph, and Orange. The deposits in Moore County have been worked almost continuously since 1850. From this section the entire world's supply is produced. They are said to be the only commercial deposits found in the United States.

During the past five-year period a number of new uses have been discovered, and new methods of beneficiation have been worked out. As a result the production has increased throughout the depression years.

The most important development in the pyrophyllite industry was the construction of a large grinding and processing plant by the Standard Mineral Company, near Hemp, in Moore County.

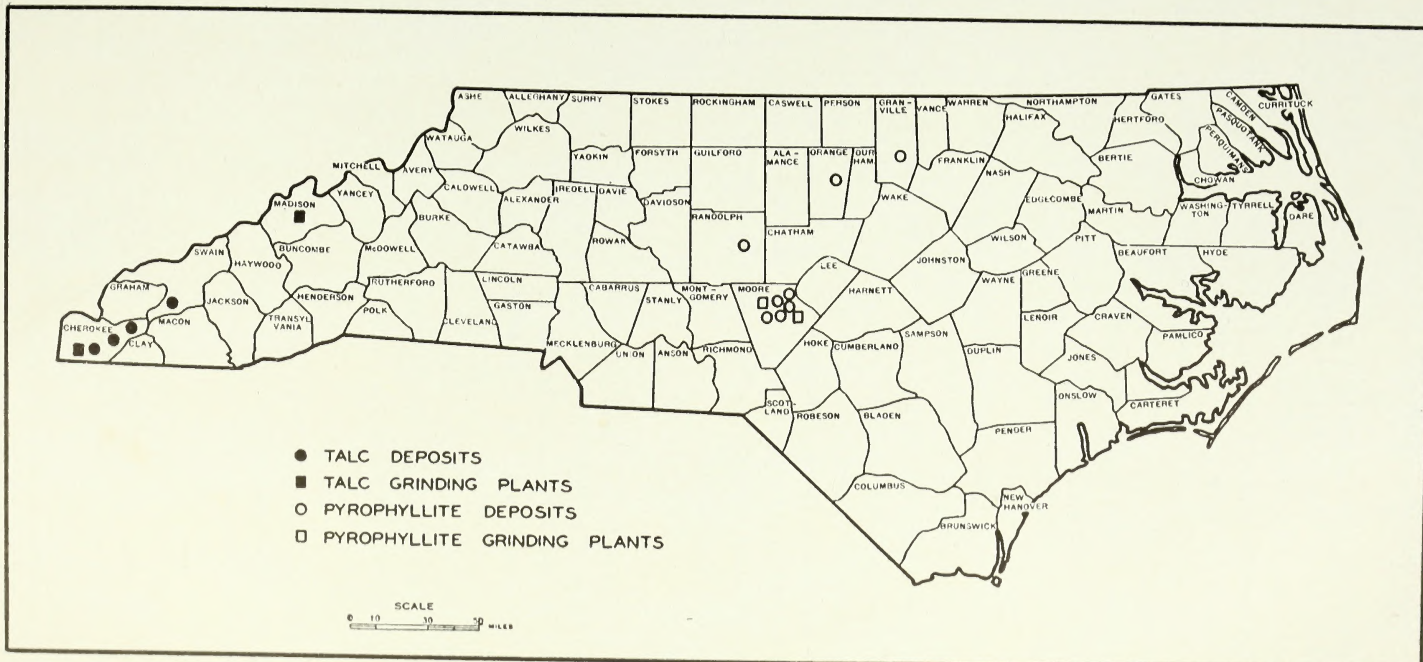


FIG. 27. MAP SHOWING LOCATION OF TALC AND PYROPHYLLITE DEPOSITS AND GRINDING PLANTS

It is reported that the plant and development work cost approximately $200,000. This is by far the outstanding development in the pyrophyllite industry in recent years.

The United Talc and Crayon Company property at Glendon was purchased by New Jersey interests, and has been producing all grades of pyrophyllite during the past four years. The mill was reconditioned and a second pulverizer installed. The capacity of the plant was more than doubled.

Another important development in the pyrophyllite industry is in Randolph County, near Staley. The Tennessee Mineral Products Company, Spruce Pine, a subsidiary company of the Roessler-Haslacher Chemical Company has bought the property and plans to develop it on a large scale.

The deposit lies four miles south of the village of Staley and is considered to be one of the largest and most important pyrophyllite deposits in this State. The available tonnage is estimated from two to four million, sufficient to supply the world for many years. The material outcrops on the surface over an area 750 feet long, 250 feet wide, and rises approximately 100 feet above the surrounding country.

Production

The production of pyrophyllite in North Carolina has increased from $81,306 in 1929 to $220,074 in 1935. This increase in production has been largely due to new uses developed for the pyrophyllite, especially in the manufacture of battery boxes. The battery box industry requires a material with no titanium or manganese, less than one-half of one per cent iron, and above 95 per cent insoluble in battery acids. With the completion of the new mills the production in the future will be much larger than in the past.

PRODUCTION OF TALC, PYROPHYLLITE AND SOAPSTONE IN NORTH CAROLINA FROM 1929 TO 1935, INCLUSIVE

Year	Value
1929	$ 81,306
1930	105,000
1931	170,250
1932	202,229
1933	135,523
1934	165,523
1935	220,074

TALC GRINDING PLANTS IN NORTH CAROLINA IN 1935

Name of Owner	Address	Location of Plant	
		Town	County
Carolina Talc Company	Murphy	Murphy	Cherokee
J. M. Kilpatrick	Marble	Marble	Cherokee
Tennessee Mineral Products Corp.	Spruce Pine	Spruce Pine	Mitchell
Standard Mineral Company, Inc. (Two Plants)	230 Park Ave., New York City	Hemp	Moore
Talc Mining and Milling Company	Glendon	Glendon	Moore

PRODUCERS OF TALC, PYROPHYLLITE AND SOAPSTONE IN NORTH CAROLINA IN 1935

Name of Producer	Address	Location of Mine	
		Town	County
Clinchfield Sand and Feldspar	Murphy	Murphy	Cherokee
Carolina Talc Company	Murphy	Murphy	Cherokee
W. R. Lunsford	Marble	Marble	Cherokee
J. M. Kilpatrick	Marble	Marble	Cherokee
Philip S. Hoyt	Franklin	Franklin	Macon
Georgia Talc Company		Marshall	Madison
A. B. Silver	Marshall	Mars Hill	Madison
Standard Mineral Company, Inc.	230 Park Ave., New York City	Hemp	Moore
Talc Mining & Milling Corp.	150 Whiton St., Jersey City, N. J	Glendon	Moore
Tennessee Mineral Products Corp.	Spruce Pine	Liberty	Randolph
Nantahala Company	Andrews	Hewitt	Swain

OLIVINE

"Olivine is a transparent to translucent mineral, named for its olive-green color, usually occuring in granular aggregates or as small disseminated glassy grains. It is a silicate of iron and magnesium, $2(MgFe)O.SiO^2$, with varying amounts of iron and magnesium, the magnesium usually being far in excess of the iron. It is found in nearly all basic (as opposed to granitic or acidic) igneous rocks. It is the principal constituent of the ultra-basic rock dunite, which usually includes small amounts of chromite, magnetite, and enstatite. Dunite is found in Georgia and in North and South Carolina as dikes and irregular intrusions varying in size from a few feet to nearly a mile across. It is one of the rocks which gives rise to the alteration products: corundum, vermiculite, chromite, asbestos, talc, chlorite, serpentine, and soapstone; although these products often are derived from the alteration of other basic rocks.

"Bricks made from magnesite, the magnesium carbonate $MgCO^3$, have long been used in the steel industry and elsewhere in cases where a basic refractory would give the best service. The only domestic magnesite deposits are on the west coast, whereas most of the consumption is in the east. This has resulted in about a third of the magnesite consumed in the United States being imported from abroad. For the last year or two some thought has been given to the possibility of using olivine as a substitute for magnesite. Several tons are said to have been mined from near Balsam Gap, North Carolina, and successfully used as a refractory for a basic open-hearth steel furnace.

"The United States Bureau of Standards has recently made a preliminary investigation on the properties of olivine in view of its use as a refractory.

"Three samples from North Carolina, one from California, one from British Columbia, and one from Russia were tested, together with a sample of calcined magnesite. The authors found that the rate of thermal expansion was fairly regular from room temperatures to 900° C. except for slight irregularities between 200° and 300° C., and again between 650° and 700° C., approximately. The total expansion ranged from 0.942 to 1.082 per cent and is somewhat lower than that of magnesite. The pyrometric cone equivalent (softening point) of the raw ore ranged from Cone 30 to above Cone 35, with those from North Carolina all above Cone 35 (approximately 1785° C. or 3245° F.). The results indicated that the material from North Carolina was sufficiently refractory to high temperatures and certain types of slag to warrant its use as a special refractory. Brick were easily made from run-of-mine material and proved satisfactory in the few physical tests to which they were subjected."*

The olivine deposits of North Carolina are confined largely to the western counties. The most important deposits are found in Macon, Jackson, Clay, Buncombe, Madison, Yancey, and Mitchell counties.

Many of the deposits are close to the paved highways and the railroad, and, therefore, are accessible to transportation facilities. The prospecting for olivine has been confined largely to Jackson and Macon counties.

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*"Forestry-Geological Review," June, 1934, Atlanta, Ga.

During the past three years, two quarries have been in operation and have produced several hundred carloads of high-grade material. The principal point of consumption has been Youngstown, Ohio. Some shipments, however, have been made to other points in Ohio, to Pittsburgh, and to Birmingham, Alabama.

The quarries which have shown a production are located one mile north of Balsam Station near the crest of Balsam Range in Jackson County. Both quarries are operating on a large olivine intrusion which outcrops at numerous places on the mountain side. At the quarries the olivine occurs in massive granular form, rather uniform in color and composition.

The principal uses so far for olivine have been in the lining of open-hearth furnaces and the manufacture of refractory brick.

Since the production of olivine began in North Carolina, several steel companies have sent representatives to North Carolina to locate large, accessible, uniform deposits. The principal impurity in the North Carolina olivine is a talc which expands causing the material to break when heated. Most of the companies tried to secure material which does not contain the small talc crystals, but, so far, no deposits have been found which are entirely free of talc.

The price of olivine varies from $6 to $15 per ton, depending on the purity of the material and the size of the blocks quarried. Most companies desire the blocks 6 to 8 inches square and 10 to 14 inches long. The blocks are usually cut by hand or trimmed with hammer and chisel. The broken material has been sold to companies which are experimenting with the manufacture of refractory brick made principally of olivine. Several companies are now experimenting with the manufacture of brick, and the results so far have been very satisfactory.

LITHIUM

The alkali metal lithium is found only in the silicates and phosphates. One of the commonest minerals containing it is spodumene. There are three spodumene minerals identified in North Carolina: the hiddenite or emerald-green spodumene, first described in 1881 from Alexander County; kunzite, the purplish spodumene, found near Spruce Pine; and the white spodumene which occurs in pegmatite dikes in a belt extending from Lincoln through Gaston to Cleveland County.

In the early part of 1936, Frank L. Hess, Principal Mineralogist, U. S. Bureau of Mines, Washington, D. C., and Oliver C. Ralston, Supervising Engineer, U. S. Bureau of Mines, New Brunswick, New Jersey, visited the deposits in North Carolina to secure information as to the possible extent of the deposits. Dr. Ralston is to make certain tests on the separation of the lithium minerals from the pegmatite dikes.

Below is a report prepared by Mr. Hess, covering the North Carolina deposits:

"Pegmatites rich in spodumene, one of the principal sources of the world's supply of lithium, occur near Kings Mountain, in North Carolina, in bands up to a half mile in length, 3 to 125 feet in width, if not wider, as well as in large masses. The occurrence of spodumene, the lithium aluminum silicate ($Li^2O.Al^2O^3.4SiO^2$), in this vicinity has been noted in publications by Graton and by Keith and Sterrett, but in neither publication was the mineral considered as of probable value, and the records have been almost unnoticed.

"Although great numbers of pegmatites, some of which carry unusual minerals, are known in the Piedmont and along the southern Appalachians, lithium minerals have been noted in few of them and hitherto only in small quantity. A little lepidolite, the lithium mica, has been found near Amelia Court House, Va., and less certainly at several other places.

"In 1881 hiddenite, the emerald-green spodumene, was described from Alexander County, North Carolina, 50 miles N. 20° E. of Kings Mountain and the mineral gave its name to a post office at that place. Several years ago a small handful of purplish spodumene (kunzite) in crystals of almost gem quality were found near Spruce Pine, N. C. So far as I know, no other occurrences of spodumene in the southern Appalachians have been noted in the literature, though Dana quotes the existence of spodumene at Ballground, Georgia, but I can find no confirmation and it seems probable that someone may have mistaken broad-bladed white kyanite for the lithium mineral. Under certain conditions, the two minerals look remarkably alike, both in hand specimens and under the microscope.

"Owing to possible much larger use of lithium salts, O. C. Ralston and I examined the deposits near Kings Mountain prelimi-

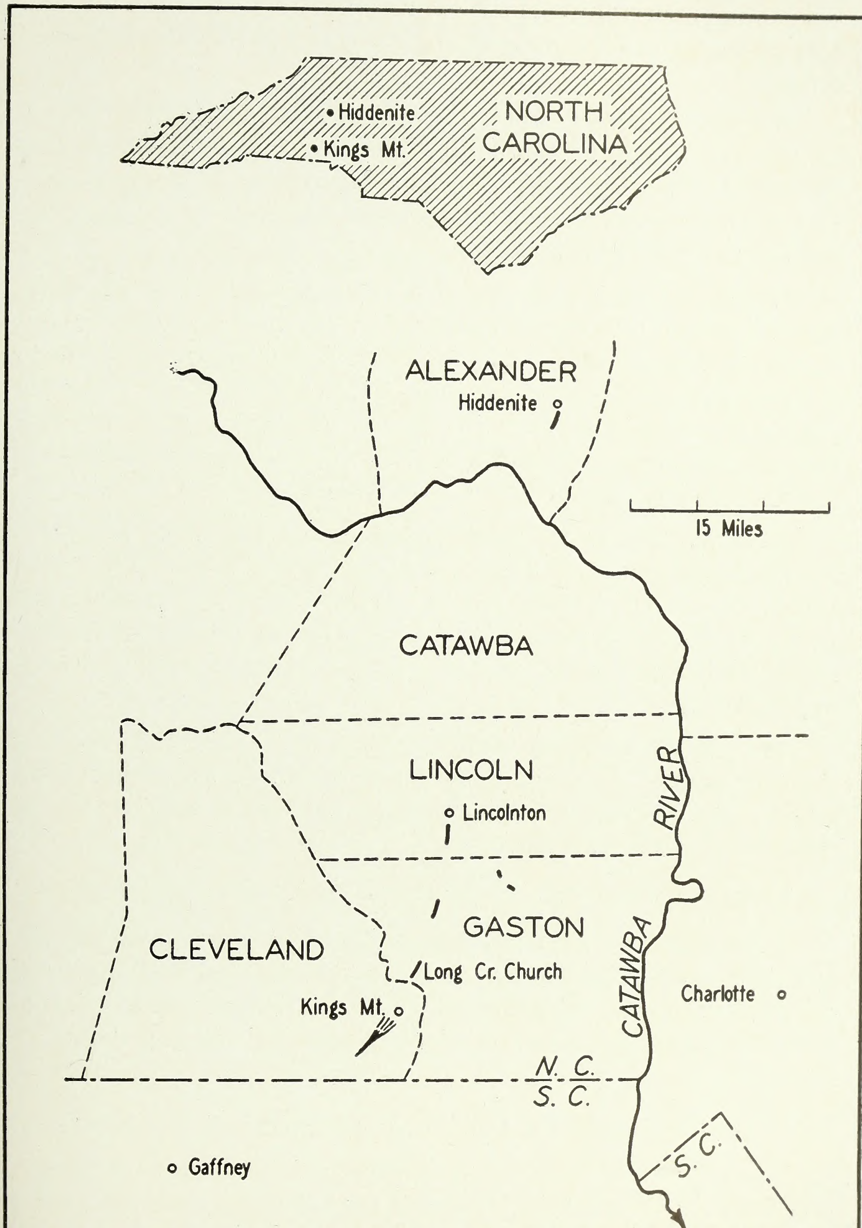

FIG. 28. MAP SHOWING LOCATION OF LITHIUM (SPODUMENE) BEARING PEGMATITES IN PIEDMONT, NORTH CAROLINA

nary to his undertaking experiments on extraction of the lithium, and at that time the data on which this article is based were collected.

"In 1905 Graton noted a mineral at the Faire's mine which he thought might be triphylite. He also noted lepidolite, and purpurite, a weathering product of triphylite. At this late date I have been unable to find any of these minerals in the dump or pegmatite at the old workings.

"When compared with the lithium deposits in New England, New Mexico and California, and especially in South Dakota and Manitoba, the deposits of the southern Appalachians as hitherto known have seemed insignificant, but a re-examination of the pegmatites near the town of Kings Mountain with interest focused on their spodumene content has given a considerably different idea of their relative importance.

"*Geology*: The area under consideration (see Fig. 28) is in the Piedmont and is rolling peneplain, mostly between 900 and 1,000 feet above sea level. Above the peneplain, 'mountains' such as Kings Mountain and Henry Knob rise as much as 800 feet above the general level, and there are a number of less prominent ridges.

"According to Keith and Sterrett, the principal rocks of the area around Kings Mountain are the Carolina gneiss, Roan gneiss, and Battleground schist, all Archean, into which is intruded the late Carboniferous (?) Whiteside granite.

"This sounds comparatively simple, but notice the definitions:

" 'Roan gneiss. Chiefly hornblende schist, hornblende gneiss, schistose diorite and diorite; in places intercalated with layers of mica schist, mica gneiss, garnet schist, and garnet gneiss; intrusive into Carolina gneiss. In places closely injected by Bessemer granite.'

"The Carolina gneiss is not much simpler. It is made up of

" 'Interbedded gneisses and schists, including mica gneiss and mica schist, garnet gneiss and garnet schist, kyanite gneiss and kyanite schist, staurolite schist, marble beds and some granitoid layers.'

"But the Battleground schist is somewhat less of a scrap heap. It is said to be

" 'Chiefly gray, bluish-black, and mottled white and bluish sericitic schist, with manganese schist member at top and a conglomerate bed near base.'

"It also contains staurolite schist.

"Pegmatites are said to cut both gneisses and the Bessemer and Whiteside granite, but apparently the Bessemer granite does not reach as far west as the spodumene-bearing pegmatites.

"The strike of the rocks follows the trend of the Appalachians. Five or six miles southwest of Kings Mountain the strike is about northeast, but nearer the town it gradually changes to about N. 20° E., and in general the pegmatites follow the strike of the country. The dips are high, from 60° to 80° northwest. Kings Mountain has much the same position with regard to the spodumene pegmatites as the pivot supporting the beam of a platform scale; there is a much greater length of beam on one side than on the other, but it is to be noted that the shorter end carries the greater weight.

"In this locality the rocks are very deeply decayed. At the Ross tin mine, near Gaffney, South Carolina, and about nineteen miles southwest of Kings Mountain, some of the rocks could be cut with a spade to a depth of 125 feet.

"The geology of these greatly metamorphosed rocks would be difficult to unravel even if unweathered and bare, and it is vastly more difficult with the heavy mantle of decayed rock ('saprolite,' as it is fondly called by many who find the Greek for 'rotten' more attractive than plain English).

"Many of the pegmatites are decayed like the other rocks, and this seems to be particularly true where they have been composd mostly of feldspar. On the other hand, some pegmatites have outcrops of remarkably fresh and unweathered rock, though in places they seem to be much decomposed just below the surface.

"The line of spodumene pegmatites begins on the Dedman farm about 3¾ miles southwest of the Kings Mountain town limit and runs almost northeast for 2½ miles. Here the general strike changes to about N. 20° E. and the pegmatites multiply and spread each side of the line to a fan-shaped group that runs almost to the boundary of the town.

"In the same strike several greatly decayed tin-bearing pegmatites outcrop in the town, but no more spodumene is known until Long Creek is reached, almost four miles northeast of Kings Mountain. Just below the Bessemer City water-supply dam, spodumene pegmatite is found on both sides of the creek.

"On the north side several masses outcrop, and a single mass 3 to 10 feet wide runs 200 or 300 yards northward, passing under the Long Creek Church. Five miles N. 28° E. on the south side of the highway is a mound about 300 feet long and 100 feet wide held up by blocks of similar pegmatite, and five miles N. 10° E. from that is another occurrence at the old Lincolnton tin mines. It is an interesting coincidence that the spodumene pegmatites also end with a tin-bearing body, though a small one, at their southwest extremity.

"The tin deposits of the Carolinas, with their chimerical hopes of wealth, follow the same line of pegmatites but are in a broader belt.

"So far as I have observed, in the spodumene pegmatites the tin is found nowhere with the spodumene.

"*The Spodumene Pegmatites:* The pegmatites, as stated in the opening paragraph, are in bands as much as a half mile long, from 3 to 125 feet wide, and in masses with approximately equidimensional outcrops that may be 125 feet across. In general they have resisted weathering so that they cap ridges and hilltops. They commonly weather into heavy blocks which spread over the surface so that what appears to be a single, wide body may be several narrower bodies, and it is possible that some may be wider than I have indicated in the foregoing.

"The pegmatites are light-colored rocks of moderate or small grain. Their freedom from colored minerals is remarkable. Even schorl (black tourmaline), common in most pegmatites, is very scarce, though a few small crystals are found here and there. Keith and Sterrett note a quartz-tourmaline vein, near the town line, which in places is about half tourmaline.

"Remarkable also is the freedom from large segregations of quartz, feldspar, or mica, and likewise remarkable is the paucity of mica and phosphates, the entire absence of graphic granite, of lithium minerals other than spodumene, and of beryl.

"A few films of pyrite, chlorite, and vivianite have been found and, at the end of one long pegmatite, a very few garnets.

"At a number of places cassiterite has been found at the side or at the end of a spodumene pegmatite, generally where the pegmatite has been replaced by quartz and muscovite. The mica is in thin, elongated plates normal to the walls. The cassiterite is similarly elongated and oriented. Spodumene is never found in this association. In the decayed feldspathic pegmatites cassiterite replaced feldspar, and some unusual crystals have been found.

"In places where the wall rocks are mica schists the mica content at the contact may be considerably increased and take the form of lenses a few inches thick and a foot or so long. Biotite in such a position is likely to carry the rare alkalis (lithium, rubidium, and cesium), and it was found to be true of biotite occurring on the W. A. Ware farm. R. E. Stevens and I hope to publish a separate technical paper on this mica.

"The bodies of spodumene pegmatites were originally intruded as a white, fine-grained mass of microcline, quartz, and muscovite. They have all been cracked lengthwise, and many show a little rough sheeting parallel to the strike. At constricted places the effects of the sheeting may almost reach schistosity.

"Along the cracks solutions brought white microcline that formed sheets which, though mostly thinner, may be 2 feet or more thick, with an extension often of many feet along the dip and strike.

"Later, other movements took place which cracked the microcline and were accompanied or followed by solutions which gnawed away and replaced the corners of the fragments, smoothing them off until they look like rolled and rounded pebbles. The commonest replacing material is quartz, largely in minute grains. With it is albite, in like small grains, and some muscovite, in thin books mostly less than a half an inch across. The aggregate looks as if, while of the consistency of oatmeal gruel, it had swirled through the cracks in the microcline and then solidified.

"In this counterfeit frozen current lie small spodumene crystals. Many of them have cross-sections with curved borders, and have replaced the rounded fragments of microcline, of which larger pieces 2 inches or more in diameter are found in all stages of replacement.

"Possibly several stages occurred in the replacement, because mere outlines mark the boundaries of some spaces once occupied by rounded microcline fragments, and the places are now filled by albite, quartz, and a little muscovite.

"Only a part of the spodumene takes the form of the replaced microcline. Some lath-shaped crystals are a foot long. A few crystals are roughly 2 to 3 inches square and 18 inches long. Few show even rough terminal planes and the prisms are irregular. Occasionally a piece is found that is almost glassy and slightly yellowish-green. In a few places the original pegmatite has been replaced by albite aplite. It contains only a little muscovite and is so fine-grained that it is almost aphanitic. Through it are tiny sheaves and sprays of spodumene crystals in part coalesced into a single larger crystal, which looks like a miniature board with frayed ends.

"Some of the particles of spodumene are not more than 0.01 mm. (1/2,500 in.) in diameter, but the microscopic particles apparently hold only an inconsiderable part of the lithium. The aplite incloses tongues of microcline and apparently has replaced the pegmatite into which the microcline was introduced.

"In some places, such as on the southwest part of the Johnny Dixon farm, spodumene has spread from cracks and has replaced the mixture of microcline, quartz, and less muscovite which preceded both the massive microcline and the spodumene.

"At Long Creek Church the pegmatite shows much of this type of spodumene. In the bottom land on the south side of Long Creek is a mass of albite aplite probably between 50 and 100 feet wide. Through it cut veins of spodumene 3 to 8 inches wide in which the spodumene crystals bristle from the walls like quartz crystals in veins.

"The aplite is intriguing. In sections for the microscope it shows quartz, albite, and muscovite in almost equal quantities but declining somewhat in the order named. It shows some gneissoid structure and typical irregular aplitic interlocking sutures—a sign that the magma was very wet. It contains no spodumene.

"What was the relation of this aplite to the pegmatites before the arrival of the microcline and the succeeding spodumene? It seems possible that it may have preceded some of the pegmatite and may have been entirely replaced by it. On the other hand, it

may have been intruded at the same time as the comparatively fine-grained pegmatites, which later received their additions of microcline and spodumene. If the latter, the aplite seems to have received only the spodumene in an almost if not quite unique form—a spodumene vein.

"*The Lithium Content:* The lithium-bearing pegmatites are marvelously consistent in that they carry spodumene almost throughout. It is not to be supposed that they are everywhere equally rich, but in nearly all of those which carry any of the mineral it is uncommon to find a part that does not show some spodumene. The spodumene is much more evenly distributed through the pegmatites than the minerals are in most metaliferous veins.

"What appeared to be representative samples have given between 15 and 20 per cent of spodumene concentrates, but there are much richer as well as much leaner parts. Analyses of the spodumene have shown 6 to 7 per cent of lithia, Li^2O, but although theory demands a content of 8.4 per cent Li^2O, very few analyses show as much as 7.50 per cent. From these considerations weathering seems to have caused little loss of lithia from the crystals in the outcropping rock, and the figures would indicate 1 to 1.40 per cent of Li^2O in the rocks, but these are merely tentative approximations.

"*Comparison With Other Deposits:* The spodumene and amblygonite deposits of the Black Hills have furnished most of the lithium mined in the United States, although several thousand tons of lepidolite carrying about 2 per cent of Li^2O have been mined at Camp Harding, nine miles northeast of Embudo, New Mexico, and probably an equal quantity from Pala, California.

"The Etta pegmatite at Keystone, South Dakota, has been far the largest producer, and 36 tons of spodumene has been produced from a single crystal. The lithia content of the spodumene is about the same as that at Kings Mountain—6 to 7 per cent—but it is said that 15 tons of waste is mined for each ton of spodumene shipped.

"Just south of Oreville, South Dakota, a spodumene pegmatite on the Hunter claims runs for a mile or more parallel with and several hundred feet above the Burlington Railroad. The peg-

matite is 3 to 20 feet wide, and the partly translucent crystals, which reach the size of a man's arm, are comparable in quantity with those in the Kings Mountain pegmatites.

"A part of the great pegmatite at Tinton, South Dakota, carries spodumene in size of crystals, occurrence, and tenor, much like the Kings Mountain deposits.

"H. C. Stockwell has described a spodumene pegmatite at Cat Lake, in southeastern Manitoba, that is somewhat similar to the Kings Mountain occurrences, but the spodumene is buried in quartz. He estimates that the quartz carries 50 per cent of spodumene, and that bands of the mixture make up from 20 per cent in the leaner parts of the mass to 70 per cent in the richer parts. The spodumene is accompanied by albite aplite. It is reported that spodumene from this region is now being imported into the United States.

"*Working Methods:* So much of the spodumene-bearing rock lies on the surface of the ground and is available in protruding outcrops that hundreds of tons of lithium salts could be produced without digging. Should exploitation be undertaken it would seem to be well to buy the loose rock delivered at a mill rather than to mine it at some particular place.

"*Concentration:* The specific gravity of the spodumene is about 3.25 and that of the gangue (quartz and feldspar) about 2.65. The difference between the specific gravities, 0.6, seems great enough to make possible the concentration of the mineral on ordinary shaking tables. However, as in the Black Hills, where the spodumene crystals are known as 'logs' from their size and structure, the crystals split like wood and make separation on tables difficult. Flotation of the spodumene or separation by heavy solutions may be commercially possible. Another possibility seems to be to separate the lithium as chloride directly from the crushed ore by treatment with dry chlorine, dry HCl gas, or, possibly, by a mixture of the two.

"Many methods of separation of lithium from the concentrated minerals have been proposed and patented. An investigation of the general problem of separation of the lithium from rock to finished product has been undertaken by O. C. Ralston, of the United States Bureau of Mines, at the Bureau's Nonmetal-

lic Experiment Station in New Brunswick, New Jersey, and concentration methods by Will H. Coghill at the Bureau's Mississippi Valley Experiment Station, in Rolla, Mo.

"*Uses:* The most widely known fact about lithium is that it has been prescribed extensively as a cure for bodily calculi. This medication has been based on the supposition that the unchanged compounds would reach the organs carrying the calculi and there make a base exchange with the insoluble calcium salts, but lithium salts are not prescribed as frequently as they were a while ago.

"Lithium (metal) has been used in fractional percentages for hardening aluminum and lead, and a lithium salt was used in the Edison storage battery, but the total consumption has of late declined.

"Lithium chloride, a salt, which is so hygroscopic that it readily extracts moisture from the atmosphere, finds some use in conditioning air, and there seems to be promise of a progressively larger use.

"Under certain conditions lithia is used in glass making, but it cannot be generally used to replace potash or soda. There is now a large consumption of alumina in glass, and it is possible that for making certain types of glass the concentrated spodumene, if sufficiently low in iron, may find a market."

BERYLLIUM

The element beryllium, sometimes called glucinum, is usually regarded as one of the rare elements. However, it is found in the common mineral beryl, $Be_3Al_2(SiO_3)_6$. The element is also found in euclase and gadolinite. These minerals have been identified in North Carolina: euclase at Morrial Mills in the eastern part of Polk County, where one crystal was found, and gadolinite has been identified from the pegmatites in Yancey and Mitchell counties.

The chief source of beryllium is from the mineral beryl, which occurs at a great number of localities associated with the feldspar and mica in the pegmatite dikes. A great deal of beryl has been shipped from the State, which was recovered as a by-product from the feldspar and mica operations.

Some very large crystals, 8 to 10 inches thick and from 2 to 3 feet in length, of beryl have been found at the Ray Mica Mine in Yancey County and at mica mines in Cashier's Valley in Jackson County. The crystals of beryl usually contain 12 to 14 per cent BeO. At a mica mine near Spruce Pine, the white, clear crystalline quartz showed a beryllia content up to 2 per cent. This is a rare occurrence, however.

Beryl has been quoted at $30 to $40 per short ton, f.o.b. mine, through 1935 and 1936. The principal producers of beryllium alloys are the Beryllium Products Corporation, Temple, Pennsylvania; and Brush Beryllium Company, Cleveland, Ohio.

The most important use for beryllium is as an alloy with other metals, especially copper. Beryllium alloyed with copper produces a very hard metal, sufficiently hard to cut steel. Also, it is reported that beryllium alloyed with copper will raise the electrical conductivity of copper 17 per cent. A contact clip made of phosphor bronze lasted seven to ten days but, when constructed with beryllium copper, was still in good condition twelve months. A vibrator cam of the same alloy was said to have shown no signs of fatigue after about two billion vibrations at the rapid rate of 230 cycles per second.

The chisels made of beryllium copper do not spark when struck with another metal; therefore, they are used at oil refineries, lacquering plants, cellulose acetate processors, and other process industries. A relatively large outlet for the beryllium product is in the airplane industry. The beryllium-nickel alloy can be tempered by precipitation hardening, and is said to have a tensile strength of 259,000 pounds per square inch, with a Brinell hardness of 460.

Even though beryllium is one of the most interesting elements and has wonderful future possibilities, it is not likely that North Carolina will be a large producer of beryllium ore or beryl, because, to date, investigations have not revealed any large deposits. The only occurrence so far found is as crystals in certain of the pegmatite dikes of western North Carolina.

MONAZITE

Monazite was formerly considered the rare mineral, without any particular economic interest. However, in 1886 on account of the demand for thoria for use in the manufacture of mantles

for incandescent lamps, considerable research was made to determine a source of supply. As a result many commercial deposits were found, a great number of which were found in North Carolina.

Monazite is a light yellow, honey yellow, reddish, brownish or greenish yellow in color, with a resinous to vitreous lustre, and is translucent to subtransparent. It is brittle with a conchoidal to uneven fracture, and is from 5 to 5.5 in hardness. It crystallizes in the monoclinic system, and some crystals have been found that were 2 inches in length. The more perfect crystals are very small ranging from an eighth to a sixteenth of an inch in length down to microscopic ones.

Monazite is essentially an anhydrous phosphate of cerium, lanthanum, and didymium, nearly always accompanied by a small percentage of thoria (ThO^2) and silicic acid, which are very probably united as thorium silicate. Some monazites contain but a fraction of one per cent of thoria, while others have shown the presence of 18 to 32 per cent. The majority contain from 3 to 9 per cent of this oxide.

Below are the analyses of samples of North Carolina monazite:

SAMPLES OF NORTH CAROLINA MONAZITE

Locality	Specific Gravity	P_2O_5	Ce_2O_3	La_2O_3 Di_2O_3	$(Y,Er)_2O_3$	SiO_2	ThO_2
Burke County, N. C.	5.10	29.28	31.38	30.88	....	1.40	6.49
Alexander County	5.20	29.32	37.26	31.60	....	0.32	1.48
Madison County, N. C.	....	....	....	....	....	....	5.00

The monazite deposits of North Carolina are confined largely to a belt covering most of Rutherford, Cleveland, Burke, Caldwell, and Wilkes counties. The rock formations in this locality are Carolina gneiss, Roan gneiss, granites, and pegmatites. The monazite occurs as small grains and crystals in these rocks. The rocks, on weathering, free the monazite which is later concentrated in transported material along the streams.

The principal uses of monazite are as a source of ceria and thoria. It is only within the last few years that the ceria has been recovered as in the early days it was thrown away. The

principal use of thoria is in the manufacture of gas mantles, but on account of its high melting point, it has a small use as a refractory material. It melts at 3000° C. and may be used to resist temperature up to 2500° C. On account of its high price and its sensitivity to sudden changes in temperature, it has not been used on a large scale. The price usually ranges from $50 to $70 per ton.

No monazite has been produced commercially in North Carolina since 1910, at which time 83,454 pounds were produced, valued at $10,104. In the last seven-year period, however, some prospecting and development work was accomplished in Burke and Cleveland counties but on account of the competition from deposits in South America and the low price obtained, no plants were erected for the recovery of monazite.

ZIRCON

Zircon is a silicate of zirconium ($ZrSiO^4$), and is commonly found in square tetragonal prisms terminated by the pyramid. It is usually of a grayish, light brown to reddish brown color; occasionally it is found colorless to red and perfectly transparent, when it becomes of value as gem material. In hardness it is 7.5, and it has a specific gravity of 4.65.

The analyses of zircon very often show from a trace up to several per cent of iron oxide. The theoretical percentage of zirconia in zircon is 67.2 per cent; while the zircon, as found in nature, varies from 61 to 66.82 per cent.

Zircon can usually be readily identified by its crystallization, and the test for zirconia.

The zirconium metal is used in flashlight mixtures and in ammunition primers. It is also used in the manufacture of steel where there is an excessive sulphur content. It is also used in nonferrous alloys, including aluminum. The dioxide is a useful refractory on account of its high melting point and resistance to attack by either acids or alkalies, combined with low porosity, low thermal conductivity, low thermal expansion, and general durability. It has been used as a protective coating for cheaper refractories, and in other ceramic products.

The principal occurrence of zircon in North Carolina is confined largely to Henderson County, near Tuxedo (Zirconia). At

this locality it occurs in a pegmatite dike as small crystals. During the last year a number of samples were take from the pegmatite, the weathered portion of the country rock and from the over-burden, but the percentage was so small that it is not likely that the mineral will be produced commercially from this deposit until the price increases considerably.

Zircon has been found also near Mars Hill, Madison County, near New Sterling, Iredell County, and near Reddis River in Wilkes County.

On account of the low price and competition from foreign countries there has been no production of zircon in North Carolina since 1911. The production that year was 3,208 pounds valued at $802. The present price of zircon ore, 55%, varies from $40 to $70 per ton. The pure zirconium is quoted at $7 per pound.

BIBLIOGRAPHY

GOLD

Laney, F. B.—Bulletin No. 21, The Gold Hill Mining District of North Carolina; N. C. Geol. & Econ. Survey, 1910.

Pogue, J. E., Jr.—Bulletin No. 22, A Report on the Cid Mining District, Davidson County, North Carolina; N. C. Geol. & Econ. Survey, 1911.

Bryson, Herman J.—Economic Paper No. 63, The Mining Industry in North Carolina in 1927 and 1928; N. C. Dept. of Conservation and Development, 1930.

Bryson, Herman J.—Bulletin No. 38, The Gold Deposits in North Carolina, 1936; N. C. Dept. of Conservation and Development, 1936.

CHROMITE

Pratt, J. H.—Economic Paper No. 49, The Mining Industry in North Carolina during 1913-1917; N. C. Geol. & Econ. Survey, 1919.

Stuckey, J. L.—Economic Paper No. 55, The Mineral Industry in North Carolina, 1918-1923; N. C. Geol. & Econ. Survey, 1925.

Bryson, Herman J.—Economic Paper No. 63, The Mining Industry in North Carolina during 1927-1928; Dept. of Conservation and Development, 1930.

IRON

Bayley, W. S.—Bulletin No. 31, Deposits of Brown Iron Ores in Western North Carolina; N. C. Geol. & Econ. Survey, 1925.

Bayley, W. S.—Bulletin No. 32, Magnetic Iron Ores of Western North Carolina and Eastern Tennessee; N. C. Geol. & Econ. Survey, 1923.

Pratt, J. H.—Economic Paper No. 49, The Mining Industry in North Carolina during 1913-1917; N. C. Geol. & Econ. Survey, 1919.

Bryson, Herman J.—Economic Paper No. 63, The Mining Industry in North Carolina in 1927-1928; N. C. Dept. of Conservation and Development, 1930.

LEAD-ZINC

Pogue, J. E., Jr.—Bulletin No. 22, A Report on the Cid Mining District, Davidson County, North Carolina; N. C. Geol. & Econ. Survey, 1911.

Pratt, J. H.—Economic Paper No. 49, The Mining Industry in North Carolina during 1913 to 1917; N. C. Geol. & Econ. Survey, 1919.

MANGANESE

Pratt, J. H.—Economic Paper No. 49, The Mining Industry in North Carolina during 1913 to 1917; N. C. Geol. & Econ. Survey, 1919.

NICKEL

Pratt, J. H.—Economic Paper No. 34, The Mining Industry in North Carolina during 1911 and 1912; N. C. Geol. & Econ. Survey, 1914.

TIN

Pratt, J. H., and Sterrett, Douglass B.—Bulletin No. 19, The Tin Deposits of the Carolinas; N. C. Geol. & Econ. Survey, 1905.

ABRASIVES

Stuckey, J. L.—Economic Paper No. 55, The Mineral Industry in North Carolina from 1918 to 1923; N. C. Geol. & Econ. Survey, 1925.

Pratt, J. H., and Lewis, J. Volney.—Volume No. I, Corundum and the Basic Magnesian Rocks in Western North Carolina; N. C. Geol. & Econ. Survey, 1905.

ASBESTOS

Pratt, J. H., and Lewis, J. Volney.—Volume No. I, Corundum and the Basic Magnesian Rocks in Western North Carolina, 1905.

BARYTES

Stuckey, J. L.—Economic Paper No. 55, The Mineral Industry in North Carolina during 1918 to 1923, Inclusive; N. C. Geol. & Econ. Survey, 1925.

MARBLE

Loughlin, G. F., Berry, E. W., and Cushman, J. A.—Bulletin No. 28, Limestones and Marls of North Carolina; N. C. Geol. & Econ. Survey.

COAL

Campbell, Marius R., and Kimball, Kent K.—Bulletin No. 33, The Deep River Coal Field of North Carolina; N. C. Geol. & Econ. Survey.

Pratt, Joseph Hyde,—Economic Paper No. 34, The Mining Industry in North Carolina during 1911 and 1912; N. C. Geol. & Econ. Survey, 1914.

KYANITE

Bryson, Herman J.—Economic Paper No. 63, The Mining Industry in North Carolina during 1927 and 1928; N. C. Department of Conservation and Development, 1930.

MICA

Pratt, Joseph Hyde, and Berry, Miss H. H.—Economic Paper No. 23, The Mining Industry in North Carolina during 1908, 1909 and 1910; N. C. Geol. & Econ. Survey.

SAND AND GRAVEL

Bryson, Herman J.—Economic Paper No. 63, The Mining Industry in North Carolina during 1929 and 1928; N. C. Department of Conservation & Development, 1930.

CLAY

Bayley, W. S.—Bulletin No. 29, The Kaolins of North Carolina; N. C. Geol. & Econ. Survey.

MONAZITE AND ZIRCON

Pratt, Joseph Hyde,—Bulletin No. 25—Zircon, Monazite, and Other Minerals used in the Production of Chemical Compounds Employed in the Manufacture of Lightning Apparatus; N. C. Geol. & Econ. Survey, 1916.

The above bibliography lists only those publications now in print and available for distribution from the North Carolina Department of Conservation and Development, Raleigh, N. C.